POWER

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Self Interviews

THE *place is the private office of J. Jeffrey Willock, manufacturer and chief owner of the biggest group of mills in B———, Penn. Time, the present. J. Jeffrey is pacing the floor in rage over the report of his new chief engineer, when J. Jeffrey Willock enters.*

□ □ □

"Willock," says the newcomer, "why this burst of anger?"

"Why? Why?" roars J. Jeffrey, "why that infernal idiot of an engineer reports that the plant's a veritable junk heap! That it wastes money like a drunken sailor! And he calls for an expenditure of $20,000 for new equipment."

"Think of it! Paying him $5000 a year to tell me how to waste $20,000. An idiot, I say, an idiot!"

"Calm yourself, Willock, analyze the case; you'll see things differently," went on his more placid self.

"Calm nothing! You're worse than he is. Get out!"

"Willock," protested the other, "your last two engineers—good men—made similar recommendations. They warned you of the weakness of the present equipment, and told you of inevitable delays and losses due to accidents and repairs."

"You ignored them both. You knew better. In your mad eagerness for big dividends you avoided needed expenditures. Now comes the reaction. Better take his tip, Willock."

Ting a ling a ling, ling. The phone rang violently.

"Engineer? Yes. What! Great God!" exclaimed Willock as he faced himself. "It's here. The main engine's cracked her frame and the flywheel's fractured. Sudden heavy overload."

"The engineer's right; I'm the idiot. But I've discovered it too late."

Flatbush Gas-Electric Station

By Charles H. Bromley

SYNOPSIS—Initially a gas plant erected in 1864 to supply the town of Flatbush, now the 29th Ward of the Borough of Brooklyn, City of New York. In 1893 an electric plant was installed. At present the electric station is evoluting from a reciprocating to an uptodate turbine installation. The water in the tank of a 5,000,000-cu.ft. gas holder furnishes water for the turbo-jet condensers. The plant buildings are heated by boiler-feed water taken from an open heater. Large tandem gas engines driving exhausters handle the gas-distribution system.

Often there is little variety in the general layout of power plants, but the plant of the Flatbush Gas Co. has some unusual features of operation and these will here be described.

Boiler and Engine Rooms

The plant initially was a small gas property erected to supply the then thinly scattered community of the town of Flatbush. A desire to have electric-arc street lighting then sprang up and horizontal tandem steam engines belted to Excelsior arc-light machines were installed; then came a desire to have incandescent electric lighting and belted two-phase, 60-cycle, 2200-volt generators driven by high-speed horizontal cross-compound steam engines were installed, this system enabling both arc and incandescent lighting to be done from the same type of machine. The belt-driven units were followed by cross-compound vertical engines direct connected to 60-cycle, 2200-volt, two-phase alternators, these vertical units being installed about 1900. All the Excelsior and Brush machines, together with the horizontal engines, have disappeared, and of the old equipment, there remain but the two vertical direct-connected units shown in Figs. 1 and 2. These two photographs show the turbines installed and the evolution which has taken place in the last 13 years from engine to turbine practice. With the completion of the turbo-unit now being installed the plant will have a capacity of 5375 kw. The switchboard is of the direct-control type.

Two 520-hp., two 250-hp., one 440-hp. and one 383-hp. hand-fired water-tube boilers with a total capacity of 2363 hp., normal rating, furnish steam for the electric plant. All boilers carry 160 lb. steam pressure and operate on a balanced-draft system. The four larger boilers are equipped with 150-deg. F. superheaters, the superheat being 80 deg. F. at the turbines. The boilers are equipped with recording gages for the balanced draft, steam temperature and steam pressure. No. 3 buckwheat coal with a mixture of 3 per cent. soft coal is burned under all boilers. The weight of coal delivered to the yard and to each boiler is recorded daily. Average CO_2 samples are collected on all runs and analyzed twice daily. Each shipment of coal is analyzed by the company's chemist.

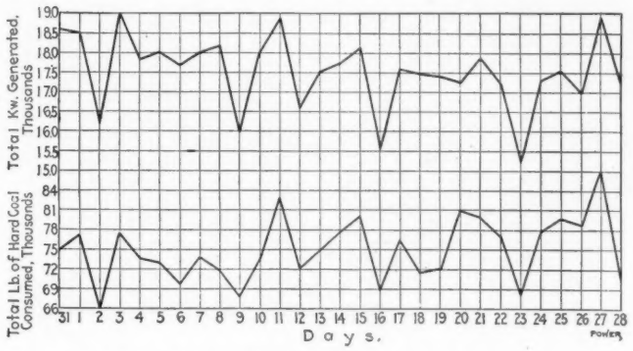

Fig. 3. Coal Consumption and Kilowatt Curves for February, 1913

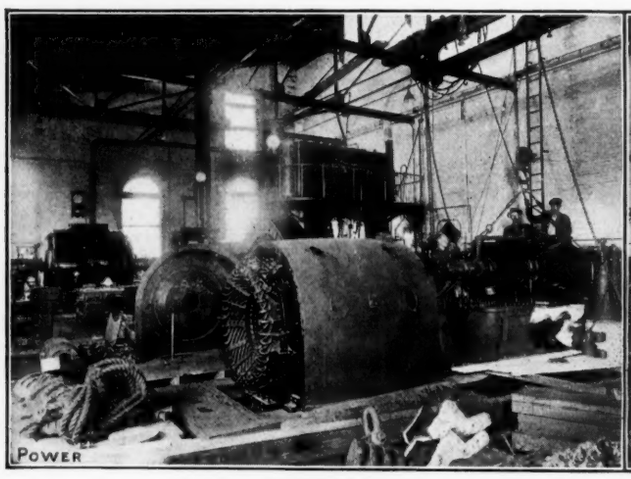

Fig. 1.

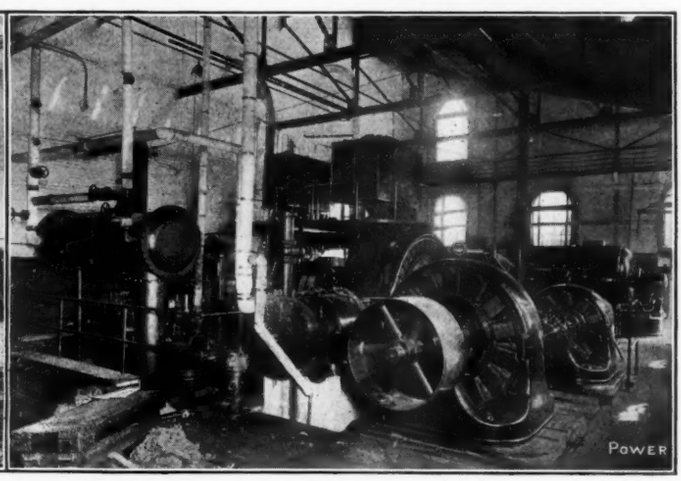

Fig. 2.

Evoluting from a Reciprocating Engine to a Modern Turbine Installation

The boiler-feed water is taken from the hot wells into which the condenser water discharges. The makeup water for the loss from the cooling towers and water used around the plant is obtained from the company's well. Curves showing daily coal consumption and kilowatt output, as well as tables showing how excess air and various percentages of CO_2 affect the boiler economy are hung in the boiler room for the guidance of the men. The interest which these tables and curves stimulate in the men is well worth the trouble in posting.

Fig. 3 shows the coal-consumption kilowatt-output

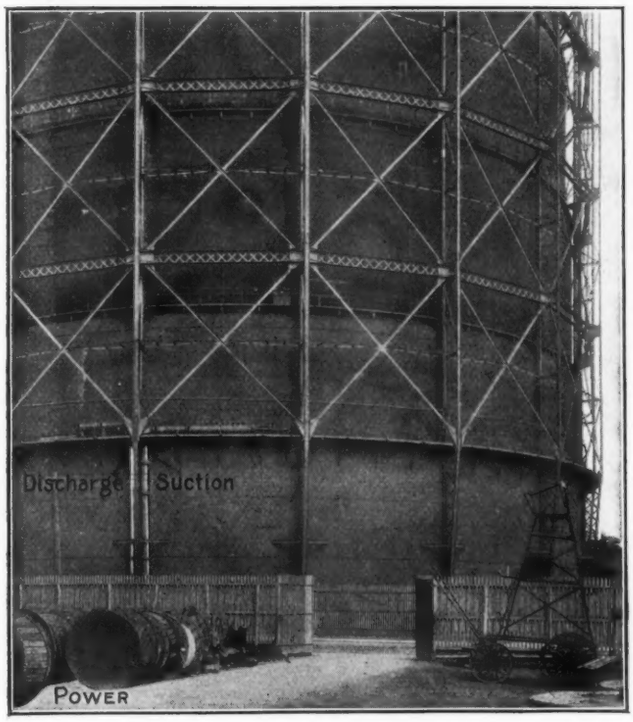

FIG. 4. CONDENSER-CIRCULATING-WATER HEADERS ON 5,000,000-CU.FT. GAS HOLDER

curves which are plotted and hung in the boiler room. Note how closely the coal curve follows the kilowatt-output curve, no doubt reflecting the interest shown by the engineers and firemen, resulting in the elimination of leaky boiler settings, improved firing methods, and a general pride in the results.

CONDENSING SYSTEM

The condensing system is indeed interesting insofar as the utilization of the circulating water is concerned. As is generally known, gas holders are provided with water seals on the different sections to prevent escape of gas. Naturally these seals must be prevented from freezing in the winter. The holder in Flatbush, a part of which is shown in Fig. 4, is of 5,000,000 cu.ft. capacity, the tank of which contains approximately 8,250,000 gal. of water. To keep this great amount of water from freezing in winter requires about 100 boiler horsepower per hour

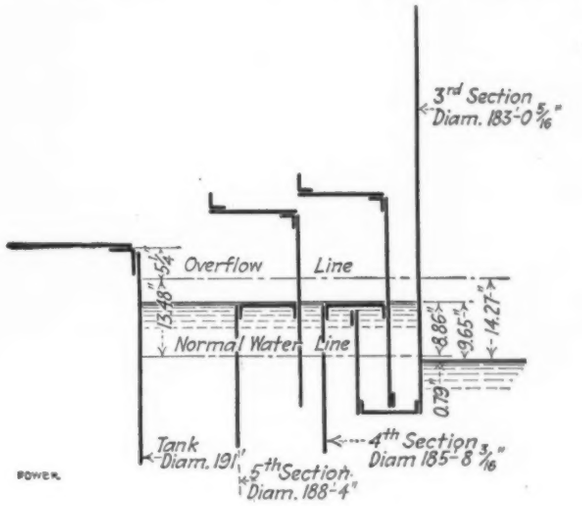

FIG. 5. PARTIAL SECTION OF GAS HOLDER, SHOWING WATER SEALS WHEN THREE SECTIONS ARE INFLATED

with the atmospheric temperature near the freezing point. Fig. 5 is a sectional elevation showing two of the seals in the gas holder. As the plant is at a considerable distance from a cheap and plentiful cold-water supply for circulating purposes, the water in this holder tank is being made use of. The turbo-jet condensers are connected to the huge tank of the gas holder which serves both as a reservoir and cooling pond for the circulating water from the turbo-condensers. Owing to the load on the turbines the circulating water of the condensers contains suffi-

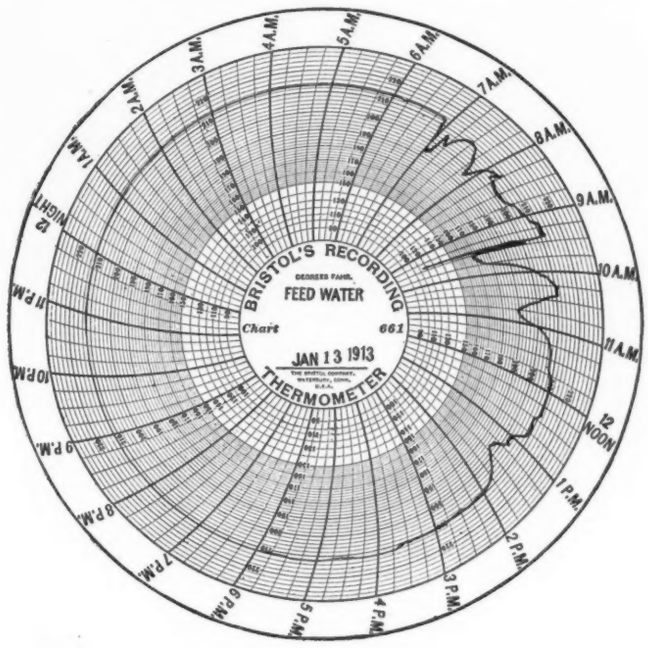

FIG. 6.

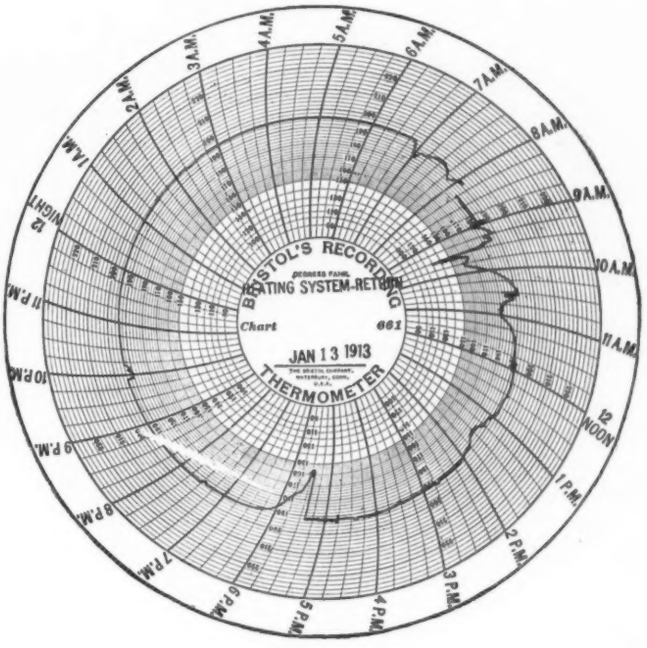

FIG. 7.

HEATING SYSTEM CIRCULATING (BOILER FEED) WATER TEMPERATURE CHARTS, SUPPLY AND RETURN

cient heat, even in exceedingly cold weather, to keep the tank at a temperature of about 90 deg. F. Due to the heavy supply of gas to the distribution system at peak hours, nearly all the cups are submerged for a short time each day, giving a new supply of warm water to the seals, which keeps them from freezing when they again emerge from the tank. This process makes it possible to dispense with the boiler used for heating the gas holder and it enables the engineers to get about 2 in. of vacuum more than they could obtain by cooling the water in their regular standard cooling towers. The whole effect is a saving of approximately $5000 a year on the coal bill.

Originally the water was conducted direct from the holder to the condensers. Later it was found that much better results were obtained by passing the water over the cooling tower, which gave it an additional cooling effect, and also discharged the vapor which may have dissolved in the water. Curves of the temperature of the water and atmosphere have shown that it is only in the most unusually severe winter weather that the seals are likely to freeze with this system of heating. Water from the condensers is discharged into the hotwells and then pumped into the tank of the gas holder. From all that the writer can learn this is the first time that such a condensing system was ever conceived of or put in successful operation. The scheme in its entirety was worked out by the engineering force at the plant.

Feed Water for Heating

The boiler-feed water is used to heat the comparatively small, though numerous, buildings about the works. Examination of the charts, Figs. 6 and 7, shows a small temperature difference between the supply and return water. This is due to the high velocity at which the water is forced throughout the system and not because there is inadequate radiation. One 2-in., two-stage and one 2-in., single-stage centrifugal pump direct connected to 5-hp. induction motors are used for this purpose. The

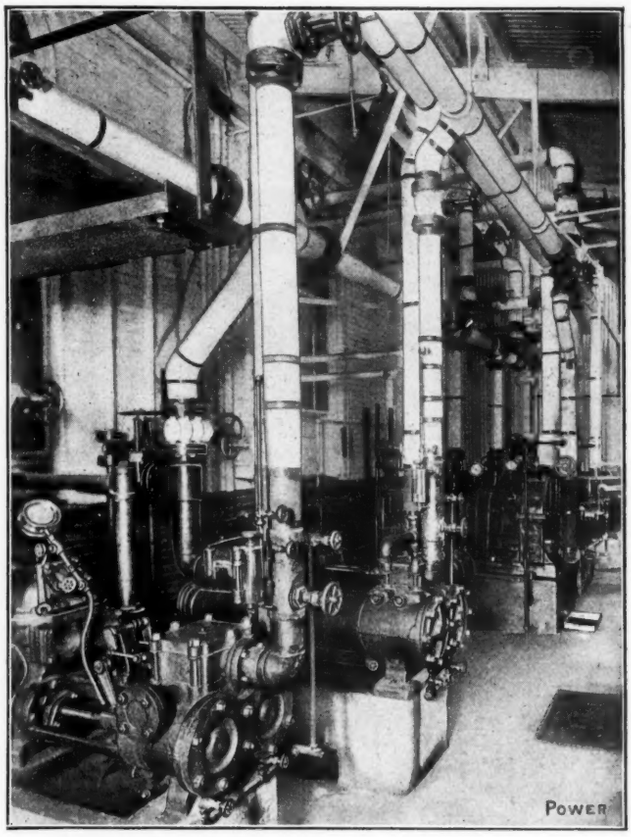

Fig. 8. Note the Well Laid Out Piping in This Pump Room

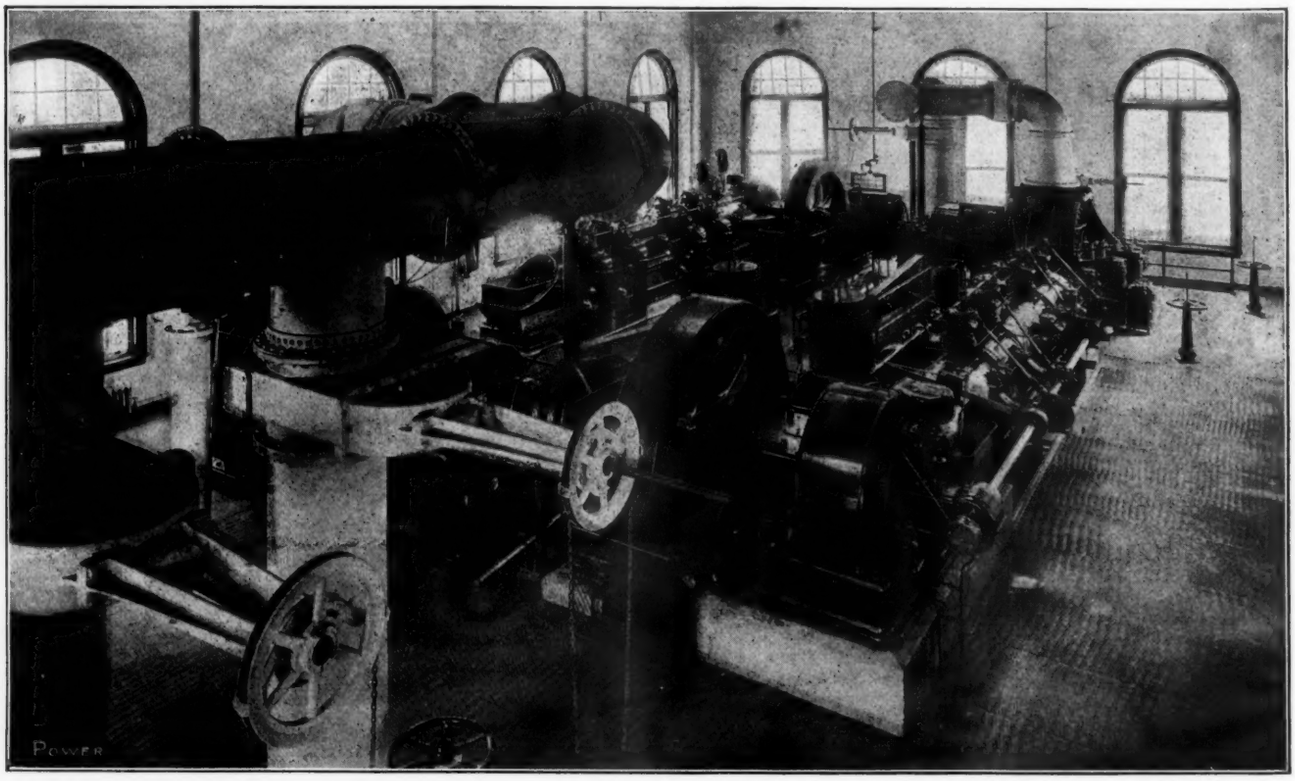

Fig. 9. The Double-Acting Tandem Gas Engines Driving Blowers for Gas-Distribution System

second pump is operated only in extremely cold weather. The water used for heating is metered on entering the system, and as the temperature of both the supply and return is recorded and the average heat value of the fuel is known, it is easy to determine how much coal should be charged to the heating system.

The equipment of feed pumps, Fig. 8, is quite complete to insure noninterrupted service. There are two duplex reciprocating pumps, two 3-in., three-stage, steam-driven turbine pumps, and a 3-in., four-stage motor-driven pump which can be used in case of emergency. Dresser fittings are used in the feed-pump suction lines to allow for quickly disconnecting the line for cleaning.

Gas Engines for Holder Service

The two tandem double-acting gas engines shown in Fig. 9 are of 400 hp. each, using illuminating gas of 660 B.t.u. per cu.ft. The engines are direct connected to exhausters, running at 175 r.p.m. and capable of delivering 750,000 cu.ft. of gas per hour against 5 lb. pressure. During the day the holder is filled with gas from a pressure main and when there is a large demand the engines pump the gas from the holder back into the pressure main whence it is delivered through governors into the distribution system at a constant pressure.

English Boiler Explosions

The annual report for the year ended June 30, 1912, on the working of the Boiler Explosion Acts, 1882 and 1890, has just been issued by the Board of Trade. During the period named 100 preliminary inquiries and six formal investigations were held under the provisions of the acts. The 106 explosions thus dealt with caused the death of 30 persons and injury to 75 others.

It is interesting to note that in 20 out of the 27 explosions which occurred on ships no person was injured and that in the remaining seven explosions 13 persons were killed and four injured.

The number of persons killed during the year from the explosion, etc., of boilers on land and sea is above the average (26.3) for the 30 years since the acts came into force, and compares unfavorably with the comparatively low death rate during the preceding three years, in which the average was only 13. This is very largely due, the report states, to two explosions, in each of which six persons were killed. There were 10 explosions from heating apparatus during the year; nine of these occurred during the cold weather at the beginning of February, 1912, and were all due to the pipes being obstructed by ice.—*The Power User.*

PRINCIPAL EQUIPMENT OF THE FLATBUSH GAS COMPANY'S PLANT

No.	Equipment	Kind	Capacity	Dimensions	Operating Conditions	Manufacturer
2	Boilers	Water tube	520 hp. each		160-lb. pres. main units supply	Babcock & Wilcox Co.
1	Boiler	Water tube	440 hp.		160 lb. pres. main units supply	Babcock & Wilcox Co.
1	Boiler	Water tube	393 hp.		160 lb. pres. main units supply	Babcock & Wilcox Co.
2	Boilers	Water tube	250 hp. each		160 lb. pres. main units supply	Babcock & Wilcox Co.
4	Superheaters				St. 150 deg. F., superheat	Babcock & Wilcox Co.
2	Main engines	Vertical cross comp.	450 hp. each	19x38x18	190 r.p.m., 25-in. vac.	Ball & Wood Co.
1	Main turbine	Horizontal reaction	750 kw.		1800 r.p.m., 27-in. vac.	Allis Chalmers Co.
1	Main turbine	Horizontal reaction	2500 kv.a.		1800 r.p.m., 27-in. vac.	Allis Chalmers Co.
1	Main turbine	Double flow (reaction and impulse)	3125 kv.a.		3600 r.p.m., 29-in. vac.	Westinghouse Elec. & Mfg. Co.
2	Main generators	A. C.	300 kw. each		2 phase 60 cycle 2200 volts	Westinghouse Elec. & Mfg. Co.
1	Main generators	A. C.	750 kw.		2 phase 60 cycle 2400 volts	Allis Chalmers Co.
1	Main generators	A. C.	2500 kv.a.		2 phase 60 cycle 2400 volts	Allis Chalmers Co.
1	Main generators	A. C.	3125 kv.a.		2 phase 60 cycle 2400 volts	Westinghouse Elec. & Mfg. Co.
1	Switchboard	Gray marble			Direct control	General Electric Co.
1	Condenser	Le Blanc Jet		3125 kv.a.	Turbine service	Westinghouse Machine Co.
1	Condenser	Tomlinson jet		2500 kv.a.	Turbine service	Allis Chalmers Co.
1	Condenser	Connersville jet		750 kw.	Turbine service	Connersville Blower Co.
1	Condenser	Worthington jet		9x14x15	Reciprocating eng. service	Worthington Steam Pump Co.
2	Feed pumps	Reciprocating		10x6x10—7½x4½x10	Boiler feed	Worthington Steam Pump Co.
2	Feed pumps	Centrifugal	200 g.p.m. against 200 lb. pressure	3"	4 stage 2400 r.p.m. turb. driven	Alberger Pump & Cond. Co.
1	Hydraulic pumps	Centrifugal	300 g.p.m. against 175 lb. pressure	5"	3 stage 1800 r.p.m. motor driven	Alberger Pump & Cond. Co.
2	Hot water cir. pumps	Centrifugal	100 g.p.m. against 195' head	2"	2 stage 1800 r.p.m. motor driven	Alberger Pump & Cond. Co.
1	Cir. pump	Volute	2500 g.p.m. against 50' head	10"	1 stage 900 r.p.m. motor driven	Buffalo Pump Co.
1	Cir. pump	Volute	3000 g.p.m. against 50' head	10"	1 stage 900 r.p.m. motor driven	Buffalo Pump Co.
1	Cir. pump	Volute	3000 g.p.m. against 50' head	10"	1 stage 900 r.p.m. motor driven	Alberger Pump & Cond. Co.
1	Well pump	Centrifugal	250 g.p.m. against 195' head	3"	3 stage 1800 r.p.m. motor driven	Alberger Pump & Cond. Co.
4	Motors	Induction	50 hp. each		2 phase 60 cycle 2200 volts 900 r.p.m.	General Electric Co.
1	Motor	Induction	50 hp.		2 phase 60 cycle 220 volts, 514 r.p.m.	General Electric Co.
1	Motor	Induction	50 hp.		2 phase 60 cycle 2200 volts 1800 r.p.m.	General Electric Co.
1	Motor generator	Synchronous	75 kw.		2 phase 60 cycle 2200 volts 720 r.p.m.	Westinghouse Elec. & Mfg. Co.
1	Motor generator	Synchronous	180 kw.		2 phase 60 cycle 2200 volts 514 r.p.m.	Westinghouse Elec. & Mfg. Co.
1	Motor	Induction	5 hp.		2 phase 60 cycle 220 volts 1800 r.p.m.	General Electric Co.
1	Motor	Induction	75 hp.		2 phase 60 cycle 220 volts 3600 r.p.m.	General Electric Co.
2	Turbines	Steam	45 hp.		150 lb. press., 2400 r.p.m., pump driven	Terry Steam Turb. Co.
1	Turbines	Steam	125 hp.		150 lb. press., 1350 r.p.m., pump driven	Terry Steam Turb. Co.
1	Cooling tower	Forced draft	40,875 sq.ft. cooling surface		2 7-ft. fans, 150 r.p.m.	The Flatbush Gas Co.
1	Cooling tower	Natural and induced draft	63,000 sq.ft. e.s.		1 10-ft. fan, 180 r.p.m.	Alberger Pump & Cond. Co.
1	Cooling tower	Worthington			1 7-ft. fan, 150 r.p.m.	Worthington Pump & Cond. Co.
2	Feeder regulators		200 amp.		2300 volts	General Electric Co.
4	Feeder regulators		150 amp.		2300 volts	General Electric Co.
1	Motor generator set		25 kw.		125 volts	Westinghouse Elec. & Mfg. Co.
2	Exciter	D. C.	11 kw.			Westinghouse Elec. & Mfg. Co.
1	Exciter generator	D. C.	35 kw.		115 volts 318 amp., 3600 r.p.m.	General Electric Co.
1	Exciter turbine	Impulse	35 kw.		150 lb. pressure 3600 r.p.m.	General Electric Co.
2	Gas engines	Tandem	400 hp.		Illuminating gas 660 B.t.u., 175 r.p.m.	Buckeye Engine Co.
1	Constant current transformers	Oil cooled	68 kw.		100 light type r.o., 2200 volts	General Electric Co.
1	Constant current transformers	Oil cooled	34 kw.		50 light type r.o., 2200 volts	General Electric Co.
1	Constant current transformers	Air cooled	71 kw.		100 light type r.n., 2200 volts	General Electric Co.
1	Constant current transformers	Oil cooled	68 kw.		100 light type r.o., 2200 volts	General Electric Co.
1	Constant current transformers	Oil cooled	34 kw.		50 light type r.o., 2200 volts	General Electric Co.
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1	Constant current transformers	Air cooled	71 kw.		100 light type r.n., 2200 volts	General Electric Co.
1	Constant current transformers	Oil cooled	34 kw.		50 light type r.o., 2200 volts	General Electric Co.
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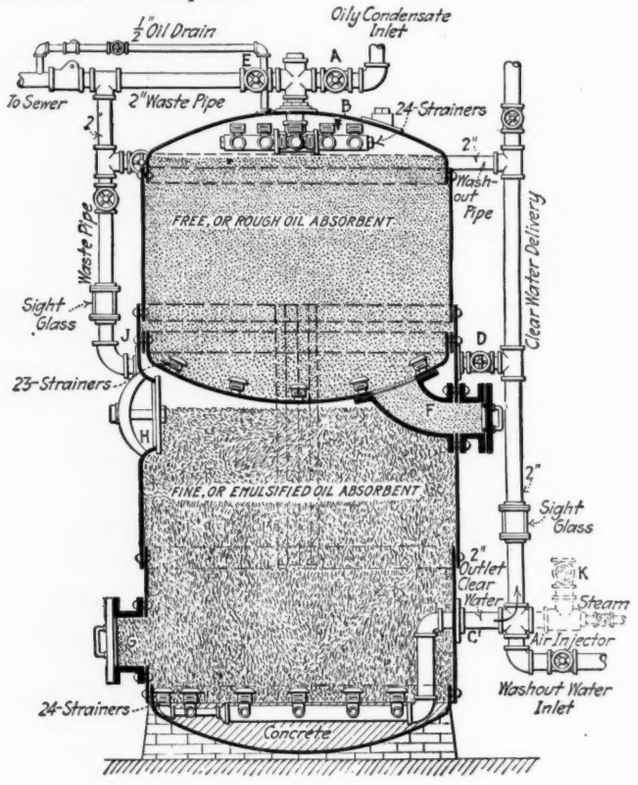
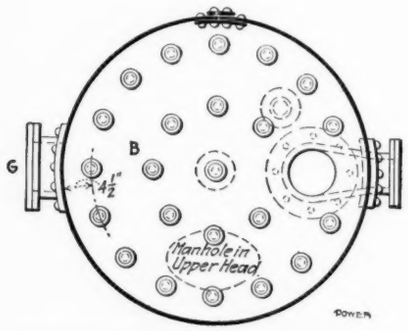
1	Constant current transformers	Oil cooled	34 kw.		50 light type r.o., 2200 volts	General Electric Co.

Krause Absorbent Oily Condensate Filter

The illustration herewith shows a filtering apparatus designed to completely remove the emulsified oil or grease from oily- and cloudy-looking condensate coming from steam separators, feed-water heaters, traps, surface condensers and pipe drips of all kinds, so that the purified water, instead of being run to waste, may be reused as a boiler-feed water and for other purposes where clear and clean water is required.





DETAILS OF FILTER CONSTRUCTION

The filter is divided into an upper and a lower compartment, the upper compartment removing the rough or floating oil by means of finely divided granular coke, flue dust or other suitable straining material. The lower compartment contains a patented combination of a fibrous absorbent silicate mixed with a granular mineral, also having strongly absorbent properties.

The condensate to be purified enters at *A*, through the strainers or sand valves *B* and passes downwardly through the upper layer of fine coke or other straining bed, leaving therein all of the rough oil from the condensate or drips from steam lines and heating system returns.

After passing through the upper bed, the condensate, which then contains only the emulsified oil, heretofore found impossible to filter, passes into the lower strainers and thence onto and through the lower bed or layer of absorbent material, wherein the last traces of oil are absorbed or removed from the water, so that after the water emerges it leaves the outlet pipe *C* perfectly clear and may then be pumped directly into the boiler or to a feed-water heater.

This filter may be worked either by gravity where the head is sufficient, or a pressure pump may be used.

After the upper layer has strained out the rough oil from the water a reverse current of hot water is admitted from time to time through the pipe *D;* the inlet valve *A* is closed and the outlet valve *E,* controlling the waste pipe, is open. As the granular material in the said upper compartment only acts as a strainer, it is retained within the filter by means of the sand valves which permit the oil and oily water only to pass through. When this granular material is, from time to time, worn down and becomes too fine it may be removed through the nozzle *F*. New straining material is then introduced through a manhole in the upper dished head.

When the fine or emulsified oil absorbent in the lower compartment is saturated or exhausted, which may take several months, it is removed through the lower nozzle *G*. A new charge of absorbent is then introduced through the manhole *H*.

Instead of wasting the rough oil from the upper compartment by emptying it into the sewer, it may be collected in a special tank from which it may be floated off and again purified by any of the well known methods. As no chemicals or solvents are used in the filtering process, and as the absorbent used is entirely neutral this tends to render the subsequent purification of such oil very simple.

Provision is made to agitate and break up, by means of a reverse current through the lower strainers, the layer of oily matter which gathers from time to time upon the upper surface of the absorbent in the lower compartment.

This oily scum and saturated absorbent may then be discharged into the sewer or other receptacle through the vertical waste pipe connected at *J* to the upper end of the lower compartment.

Steam and air to agitate the absorbent are introduced by means of an air injector and steam connection, as shown at *K*.

This process, which is patented in this and other countries, works with either hot or cold water, requires no chemicals, alum, or other solvents and is a direct process of filtration capable of rendering the condensate perfectly clear and free from oil, and is now giving entire satisfaction in numerous installations.

When arranged horizontally, so as to require less height, this filter is readily adapted for marine use, where a clean feed water is even more in demand than it is on land, and where the dangers of using oily feed water are much more serious.

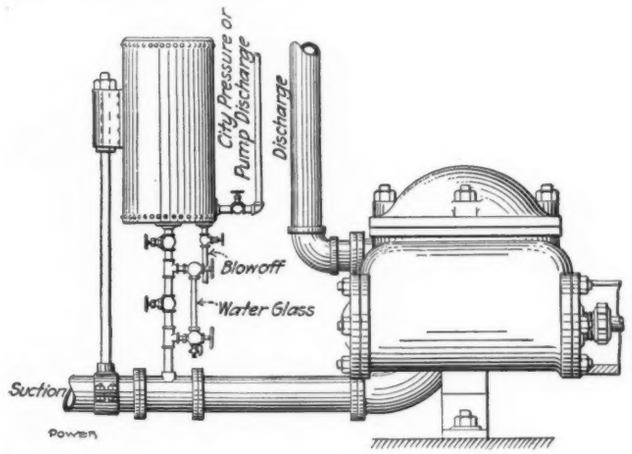
Where efficient oil separators in the steam line are used or an effective separation of the coarser oil is carried out by means of turkish towelling or multi-screen filters, the upper chamber of this absorbent filter is arranged to give double the filtering capacity by omitting the coarse granular bed and substituting the fibrous absorbent instead.

This filter is built in any size up to 12 ft. in diameter, depending upon conditions, by A. E. Krause, 345 Fairmount Ave., Jersey City, N. J.

Boiler Graphite Feeder

A satisfactory feeder for boiler graphite is illustrated herewith. It consists of a reservoir and piping equipped with valves by which the reservoir may be cut out from all water pressure. When the water-inlet valve is opened and the city water pressure is applied to the reservoir, a combination of water and graphite is fed through an outlet valve at the bottom of the reservoir into the feed water on the suction side of the pump. The amount of water saturated with graphite passing to the pump can be adjusted by noting how fast it is traveling through the water glass.

When the contents of the reservoir become exhausted the valves are closed and the reservoir is emptied through



PIPING OF THE GRAPHITE FEEDER

a drain valve. After draining off the clear water the reservoir is again filled with graphite and the feed regulated as before.

The illustration shows the manner in which the feeder, which is made by the United States Graphite Co., Saginaw, Mich., is connected with the pipe line at the suction side of the pump.

Combo Combination Water Column

The combination water column, described herewith, is simple in design, compact and is a combination of water column, whistle alarm, electric water gage, recording panel and graduated feed-water regulator attachments, which are operated by a compound lever system of hinged-pin construction contained within the main body. It is manufactured by the Combo Engineering Co., Inc., Union Springs, N. Y. This lever system is brought outside on small hinged shafts upon which are mounted levers to operate all attachments.

Inside of the main body, Fig. 1, a large float valve is connected to the main lever which is hinged on a shaft and operates the individual levers. The whistle, Fig. 2, is mounted upon the upper head; the operating lever is connected by two rods to a rocker-arm fitted upon the shaft mentioned. As the water level changes the rocker-arm rotates, and as the rods are provided with adjusting locknuts, the whistle levers can be regulated to blow the whistle at any high- or low-water level desired.

On the upper side of the upper head, opposite the whistle lever is a lever connecting the main shaft with

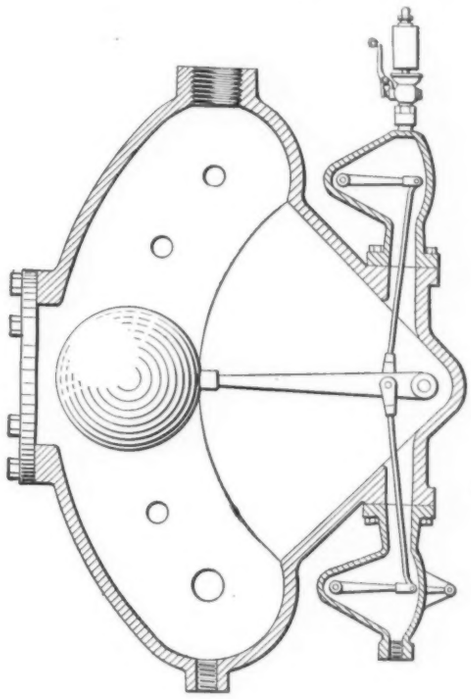


FIG. 1. SECTION THROUGH MAIN BODY OF COLUMN

terminals which are connected by wires to the signal gage, which consists of five lamps connected to as many contacts on the alarm head. The contacts are in definite relation to the water level so that the lamp corresponding to the exact water level is always lighted. Several

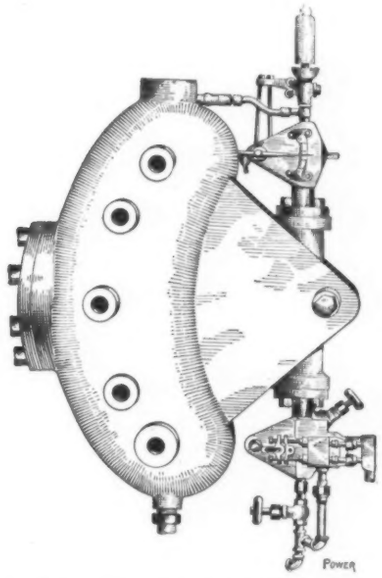


FIG. 2. EXTERIOR VIEW OF WATER COLUMN

gages can be connected to a unit. The lamps at the top and bottom have red bulbs. A buzzer can be connected with the lamps for high and low water.

A special valve regulates the flow of feed water. It is connected to the lower head and is operated by the lever system inside the column. When the boiler is steaming

the water level is maintained at any point above or below the middle gage by regulating an adjusting screw which changes the time when the four contacts unseat the disk valves in the special valve with relation to the position of the float, which is at the actual water level in the boiler.

Ideal Indicator Hook

This little device has been designed to connect the indicator cord with the pin on the engine crosshead with ease and certainty, under any conditions and at any speed. In Fig. 1 is shown the hook in position to connect to the crosshead arm or any other device moved by the crosshead.

By holding the shank of the hook lightly between the fore and middle finger, as shown, and advancing the hand until the moving arm strikes the trigger of the hook, the spring and hook incloses the arm. As the arm moves in the opposite direction the hook is carried away from the fingers. This enables the operator to make connection without injury to himself, or trouble in performing the operation.

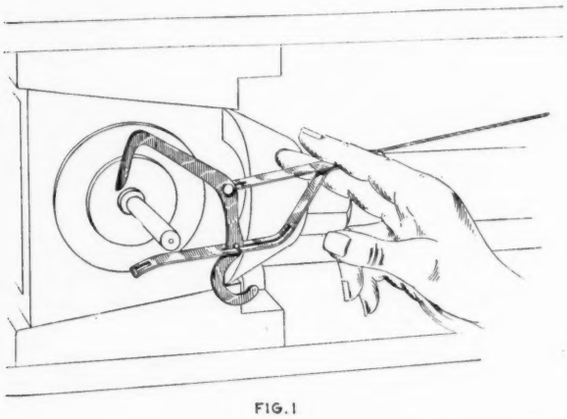


FIG. 1

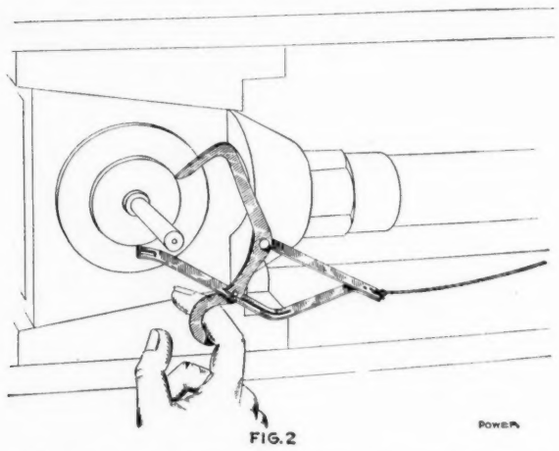


FIG. 2

HOOKING ON AND OFF IDEAL INDICATOR HOOK

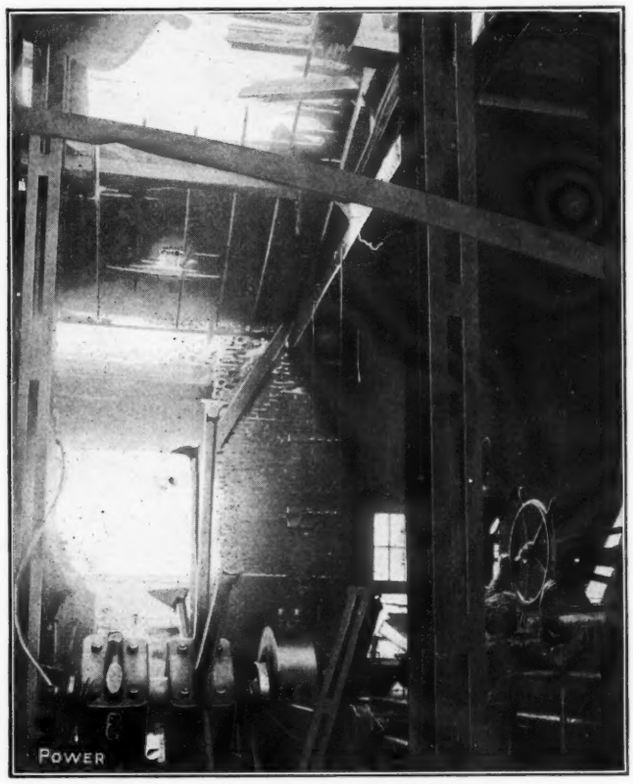
In Fig. 2 is shown the releasing position. By placing one finger beneath the cord and then advancing it far enough to engage the curved end of the trigger, the hook will be disengaged from the arm and the device will be left suspended on the operator's finger. The hook will work in any position, and with either a round or flat arm. It is made of steel, nickel-plated, and weighs less than one ounce. It is manufactured by Joseph Stewart, 406 East Millville Ave., Hamilton, Ohio.

Loosened Idler Pulley Wrecks Flywheel

BY LLOYD V. BEETS

The accompanying illustration gives an idea of the havoc wrought by the recent bursting of a 40-ton flywheel in the engine room of the Liberty Flouring Mills, South Nashville, Tenn.

The 32x60-in. Corliss engine was developing about 1800 hp. The 22-ft. flywheel was double, as shown, each



PECULIAR FREAK OF FLYWHEEL EXPLOSION

wheel having a 36-in. face or a combined face of 6 ft. The spokes broke off short at one hub, but the spokes on the other were left intact with a little of the rim adhering to them. Portions of the wheel went through a thick brick wall, making an opening 11x30 ft. in size, wrecking a box car on a siding outside of the building, in which a negro laborer was killed. This hole in the roof is a little back toward the cylinder from the crankshaft end of the engine.

The wreck was caused by a large tightener pulley breaking away from its mooring and bumping into the flywheel, knocking out a section of the rim, after which the entire wheel went to pieces.

A few minutes before the wreck the engineer's attention was called to this tightener by a noise, which was out of the ordinary, and when it left its place he was on the other side of the flywheel in the act of tightening it. While the flywheel was tearing itself to pieces the engineer closed the throttle.

The safety stop was broken, but the engine did not speed up perceptibly before steam was shut off. Other than the loss of the flywheel the engine did not suffer. The damage was estimated at $5000.

Standard Dimensions for Brass Flanges

On Sept. 17, 1913, the Committee of Manufacturers on Standardization of Fittings and Valves adopted the dimensions given in the accompanying tables as standard for brass flanges. These schedules are to be effective Jan. 1, 1914. With reference to the flanges the bolt holes are to be drilled $\frac{1}{16}$ in. greater than the bolt diameter for sizes 2 in. and smaller and $\frac{1}{8}$ in. greater for sizes 2½ in. and larger. The flanges are to have plain smooth faces, and when coupled with extra-heavy iron flanges, valves or fittings, the latter should have the raised surfaces faced off.

TABLE 1. STANDARD FLANGES FOR PRESSURES UP TO 125 LB.

Size In.	Dia. of Flange, In.	Thickness of Flange, In.	Bolt Circle, In.	No. of Bolts	Size of Bolts, In
¼ & ⅜	2½	7/16	1 11/16	4	⅜
½	3	7/16	2⅛	4	⅜
¾	3½	9/16	2½	4	⅜
1	4	9/16	3	4	½
1¼	4½	5/8	3½	4	½
1½	5	11/16	3⅞	4	⅝
2	6	¾	4¾	4	¾
2½	7	13/16	5½	4	¾
3	7½	⅞	6	4	¾
3½	8½	15/16	7	4	¾
4	9	15/16	7½	8	¾
4½	9½	15/16	7⅞	8	¾
5	10	15/16	8½	8	¾
6	11	15/16	9½	8	¾
7	12½	1	10½	8	¾
8	13½	1 1/16	11½	8	¾
9	15	1 1/16	13¼	12	¾
10	16	1	14¼	12	¾
12	19	1 1/16	17	12	¾

TABLE 2. EXTRA-HEAVY FLANGES FOR PRESSURES UP TO 250 LB

Size In.	Dia. of Flange, In.	Thickness of Flange, In.	Bolt Circle, In.	No. of Bolts	Size of Bolts, In.
¼ & ⅜	3	½	2	4	½
½	3½	½	2⅜	4	½
¾	4	9/16	2¾	4	⅝
1	4½	5/8	3¼	4	⅝
1¼	5	11/16	3⅞	4	¾
1½	6	13/16	4½	4	¾
2	6½	⅞	5	4	¾
2½	7½	15/16	5½	4	¾
3	8¼	1	6¼	8	¾
3½	9	1 1/16	7¼	8	¾
4	10	1 1/16	7¾	8	¾
4½	10½	1 1/16	8¼	8	¾
5	11	1 1/16	9¼	8	¾
6	12½	1	10½	12	¾
7	14	1 1/16	11¾	12	¾
8	15	1 1/16	13	12	¾
9	16½	1 1/16	14	12	1
10	17½	1 1/16	15¼	16	1
12	20½	1 1/16	17¾	16	1 1/8

❖

Tight Settings for Water-Tube Boilers*

The brickwork of every boiler should hold the heat. For that purpose, first, the passages for heat outward through the setting should be effectively restricted, and, second, there should be no cooling off of the hot gases by drawing large quantities of cold air into the flues.

This twofold purpose may be attained by making the setting thick enough, of material having little porosity to air—glazed brick, for example—with closest possible joints, these to be well filled and cracks in the masonry to be avoided.

The joints should not be more than $\frac{5}{16}$ in. wide outside and $\frac{3}{16}$ in. inside. With firebrick work the mortar used for filling should have the composition of the bricks. It is advisable, if at all possible, only to fill the joints after the setting has been in service for some time and is therefore perfectly dry.

The following are rules for avoiding cracks in the setting:

It is especially important to lay a good foundation. The boiler setting is to be treated like the masonry of a house and adequate foundations are particularly needed where the weight of the boiler is to be carried from the ground.

Further, the boiler setting must be well tied, which is especially true for the parts of the masonry around the fire hearth. It is proper to construct the ties as also carriers for the weight of the boiler and either to lay the boiler upon the ties or hang it therefrom.

The play needed for expansion must be given to the body of the boiler and no thrust against the setting must be permitted. Where parts of the boiler extend through the setting, some play should be allowed and the masonry at these places should be secured with iron framing. The resulting crevice is to be closed with asbestos wool, rope or sheets. Likewise, all openings required in the setting are to have iron framing and be well packed. Entrance openings are to be walled off behind the door to a thickness of half a brick and plastered with clay mortar.

No part of the masonry should rest on the boiler itself, but each should have its own support.

In the thick side walls it is advisable to leave insulation spaces from 2 to 4 in. wide, averaging about 3 in., thus dividing the brickwork into an inner and outer wall. Every five or six courses the two walls are connected by two superposed courses, but openings are left in them to unite the insulation spaces.

Where these bridging courses are inserted there are employed hoop-iron or woven-wire inserts, which in case of expansion by heat give the inner wall body a great freedom of movement with respect to the outer one, yet connect the two with adequate rigidity. Also, to prevent cracks, inserts of hoop-iron, etc., can be laid in the joints of the brickwork.

The inner wall should be made not less than 16 in. thick, so that for an open space 3 in. wide and an outer wall one brick thicker, the minimum wall thickness is 27 in.

If the foregoing rules are observed the setting will answer the requirements that were laid down at the start. The speaker gave also rules for protecting the masonry around the furnace and mentioned special packing material of different manufacturers. Also for packing and to a certain extent encasing the surface of the setting, there are used single and double coats of tar, oil-paint and water glass (potassium or sodium silicate). For filling the cracks that occur, there may be used loam and molasses, loam with infusorial earth, tar with infusorial earth, water-glass and loam with horse manure.

For packing the cracks that occur it has proved effective to use strips of linen fastened with broad-headed nails to the cracked places and spread with plaster of paris stirred in water.

If lack of room compels the use of thin outer walls, they can be effectively tightened and strengthened by covering with sheet-metal plates and filling the crevices.

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Elaborate plans are being laid down for the storage and handling of coal at the Panama Canal terminals. There will be two main coaling plants, one at Cristobal and the other at Balboa. The former is to be the larger and will have a capacity for 100,000 tons under-water storage as a reserve for naval use, 100,000 dry storage for canal use and 100,000 tons for emergency use. At the Balboa plant there will be capacity for 100,000 tons wet storage, 80,000 tons dry storage and 30,000 tons for emergency use.

*Abstract of a report by Chief-Engineer Pietzsch presented at the convention in Munich, of the International Association of Steam Boiler Inspection Societies; translated from "Glückauf."

Locomobiles on the Uniflow System

By Dr. Alfred Grademvitz

It will be remembered that in the uniflow engine, the flow of steam and accordingly the flow of heat is in the same direction. The steam enters at both ends of the cylinder and issues from its center, undergoing on its path no change in direction. The ends where the steam enters are accordingly never cooled by the escaping steam, thus eliminating a large source of loss obtained in ordinary steam engines. The single-cylinder Stumpf engine has a steam consumption as low as the best of compound engines, and besides the steam consumption remains practically constant within wide limits of load. A marked advantage of the Stumpf engine is its simplicity.

A firm of German builders, the Maschinenfabrik Badenia, of Weinheim, has, with others, been building a locomobile designed on the Stumpf system. In this locomobile, condensing is effected in an injector condenser, the vertical air pump of which is driven from a crankpin mounted on the flywheel hub. The feed water is heated in a counterflow preheater. The boiler combined with the engine in a compact unit is equipped with removable tubes, which are arranged to give easy access for cleaning. The boiler shell and the superheated steam-supply pipe are thoroughly jacketed to prevent any appreciable loss from radiation. The boiler and superheater have been so proportioned that a superheat upward of 250 deg. F. is available at normal loads. The superheater is of the thin-flow type (on the Platz system) made up of tubes arranged in front of the boiler tubes and traversed by steam in a direction opposite to that of the gases. The superheater travels on rollers inside the casing, and is so arranged that the smoke may be discharged toward the top or downward.

In the case of large condensing engines, a preheater is used and encompasses the superheater, insuring a further utilization of the gases escaping from the superheater. This preheater consists of two systems of hemispherical tubes traversed by the boiler-feed water in a counterflow direction to the gases. These systems are connected with the feed-water pipe and with one another. The superheater has high efficiency in spite of a relatively small heating surface as the steam is distributed into such thin currents that the heat of the gases is readily absorbed.

Horizontal grate furnaces are used exclusively in the case of ordinary bituminous coal. An extra-large horizontal grate can be employed in connection with low-grade coal or lignite, while stepped grates are found most suitable in the case of sawdust, and the like. Coal-fired boilers of more than 100 hp. are preferably equipped with automatic stokers. Apparatus for firing liquid fuel can also be provided.

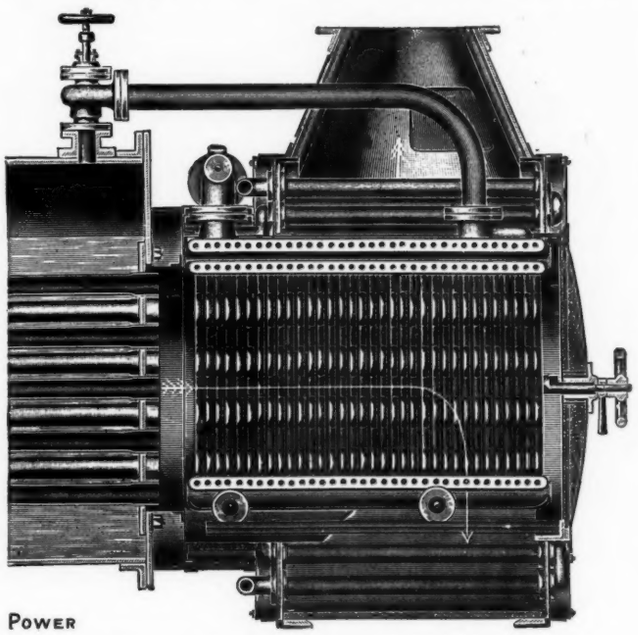

Fig. 2. Boiler Equipped with Both Superheater and Preheater

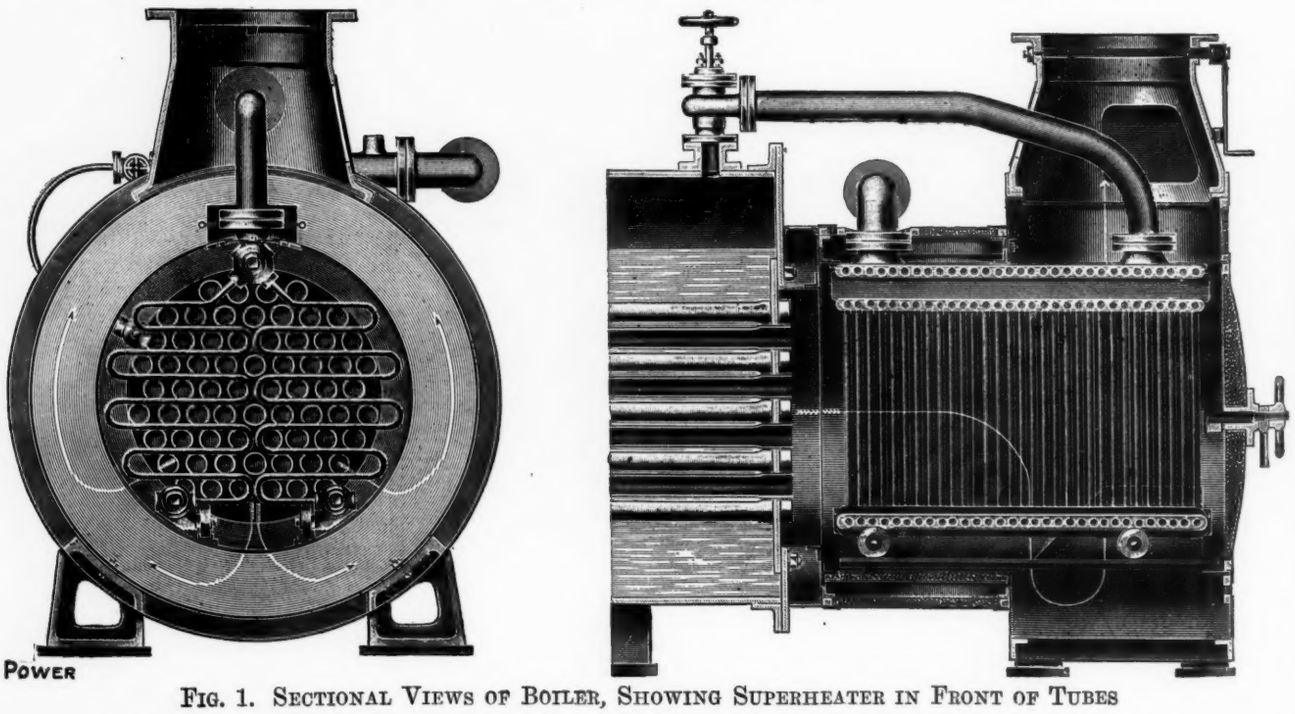

Fig. 1. Sectional Views of Boiler, Showing Superheater in Front of Tubes

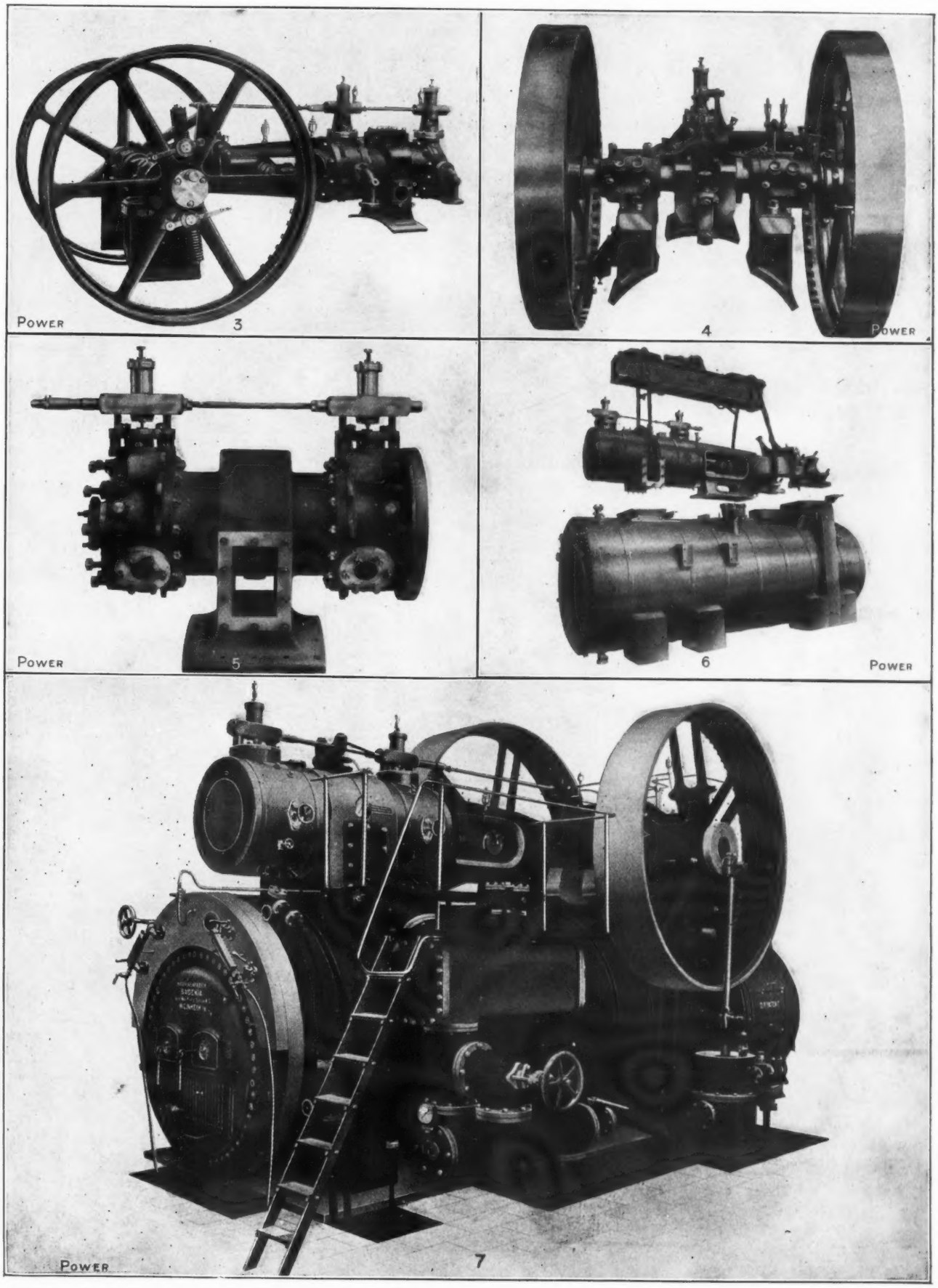

FIG. 3. THE ENGINE BEFORE BEING FITTED ON BOILER. FIG. 4. VIEW ACROSS CRANKSHAFT. FIG. 5. CYLINDER AND VALVE-GEAR. FIG. 6. ERECTING LOCOMOBILE. FIG. 7. LOCOMOBILE ASSEMBLED AND READY FOR ACTION

ELECTRICAL DEPARTMENT

Comparison of Lead-Sulphuric and Edison Types of Storage Battery

By Eugene Oster

The lead-acid battery, due to its priority, has been utilized in all applications where a storage battery can be used; its largest field is for power-house work. Owing to its high efficiency, it is improbable that its supremacy in this field will be endangered by any other type of battery, since a difference of a few per cent. in efficiency is usually the determining factor in the selection of a piece of power-plant apparatus.

The Edison battery, while originally intended to fill a need in automobile work, has recently extended its field of usefulness to include a great number of applications. It is now being used in self-contained car service, for propelling mine locomotives, for train lighting and for home lighting in isolated districts. Its largest field, however, has been in the commercial truck service, where light weight, fool-proof construction and simplicity of care render it well suited for traction and portable use and offset its slightly lower efficiency.

The advantages and disadvantages of the two types will be made more apparent by a detailed examination of their respective characteristics; the comparison here intended, including construction, care and management, efficiency, capacity, life and cost.

The Lead Cell

The lead-acid battery consists of two electrodes or sets of electrodes, the positive and negative, immersed in the electrolyte. The two electrodes are sponge lead (Pb), for the negative, and peroxide of lead (PbO_2), for the positive, the electrolyte being dilute sulphuric acid. The hard, velvety brown chocolate-colored positive, and the soft, light gray negative element, are very readily distinguishable.

Plates

Storage batteries of the ordinary lead-sulphuric type are divided into two general classes—the Planté and the Faure. The Planté type of plate is constructed of solid sheet lead so fashioned as to present a large area to the action of the electrolyte. The active material is formed on the plates, either electrically, by charging and discharging (commonly called "forming") or chemically.

In the Faure type the active material is applied mechanically to lead conducting plates or grids, and for this reason it is commonly called the "pasted" type. The positive plate is made of lead upon which a coating of peroxide of lead has been formed or mechanically applied. The negative plate is of pure lead with a spongy or porous surface, and the plain lead body of each plate serves as a support for the active material.

All the materials of the plates, the grids, spongy lead, lead peroxide, and lead sulphate, are practically insoluble in the sulphuric acid. The electro-chemical action which takes place in the cell slowly oxidizes the grids and causes them to disintegrate. The lead sulphate formed during discharge has a greater volume than either the spongy lead or the lead peroxide; consequently, there is expansion and contraction of the active material. The inability of designers to provide for this change of volume has been responsible for many troubles. Moreover, the lead peroxide of the positive plate is somewhat noncohesive, and during the subsequent gassing at the end of the charge some of it falls off, forming sediment, which if allowed to accumulate will short-circuit the plates. This loss of active material, unless compensated by the corrosion of the exposed lead surface to form new lead peroxide, results in a decrease in the capacity of the plate. The spongy lead of the negative plates being quite cohesive does not fall off if the cells are kept free from short-circuits and foreign materials, but it gradually becomes more compact and through the diminution of its porosity its capacity decreases. The rate of this decrease is greatest at the start and finally becomes very small. The negative plates are usually given sufficient initial capacity to provide for this shrinkage.

Separation and Insulation

In order to keep the plates apart and thus prevent short-circuits, rod or diaphragm separators are used in all batteries except those in which the plates are covered with hard rubber or celluloid envelopes. Where permanency is desired, the only permissible materials are hard rubber, glass and earthenware. Wood separators are extensively used, but must be replaced each time the cells are moved. Soft vulcanized rubber cannot be used for permanent work, due to its rapid disintegration in the acid.

Electrolyte

The electrolyte is sulphuric acid, diluted with sufficient pure, distilled water to bring it to the required density, the acid in every instance being poured into the water. The density varies with the condition of the battery and also has a very important bearing on its operation. If it be too high or too low, excessive sulphation is facilitated and the plates are liable to depreciate rapidly. The usual limits in practice are 1.170 to 1.195 when discharged and 1.190 to 1.225 when fully charged.

Containing Cell

Rubber and celluloid are used almost exclusively for traction and portable cells; glass is limited to stationary batteries. While the life of a storage battery is much longer when installed in glass jars, because it permits examination of the plates, the cost of the glass and its tendency to crack under temperature changes has caused it to be avoided in large sizes. Because of their high initial cost and short life, glazed earthenware containers have not come into extensive use. Wooden lead-lined tanks are very largely used for large station batteries, but are somewhat expensive.

Assembling and Installation

The individual plates are assembled to form a complete cell, by "burning" to a common lead bar or strip, all plates of like polarity. The cell terminals are then joined by means of bolts or by "burning." The former method is the more expedient, though open to the objections that the bolts must be frequently inspected to prevent loose connections and also that all connections must be protected from the acid spray by a coating of asphaltum or vaseline. The "burning" method requires the service of a skilled workman and special apparatus; hence is rather expensive, though permanent. It also renders the plates less capable of being disassembled for cleaning than does the bolt connection.

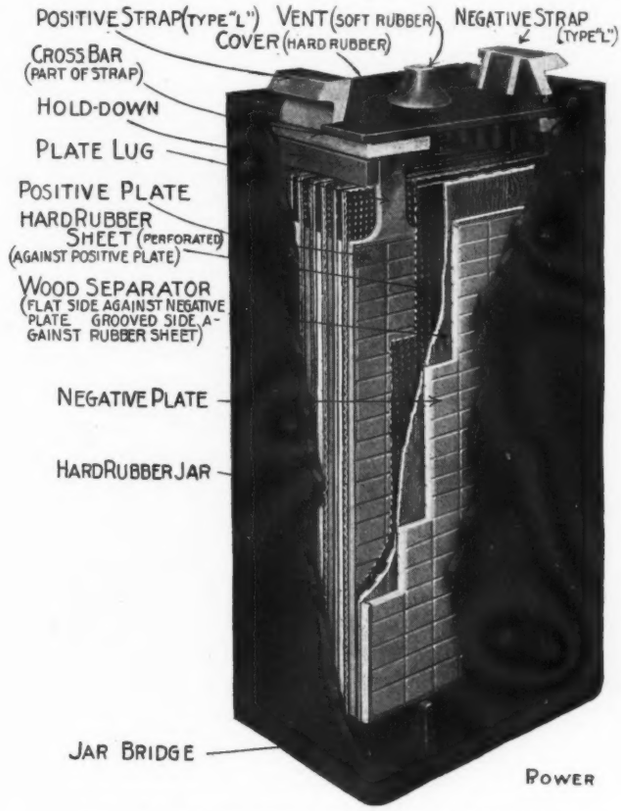

Fig. 1. Gould Cell Partly in Section

Batteries should be installed in especially prepared rooms, dry and arranged for maintaining a moderate temperature during cold weather. The room should be well ventilated and accessible, and the floor should be covered with asphalt, tile or vitrified brick, and should slope slightly toward numerous discharge drains. All metal work near the batteries must be lead covered, and any metal work subjected to acid fumes should be painted with acid-proof paint.

Care and Management

On continuous discharge the one-hour rate should usually not be exceeded, and this should last only a short time, say, 20 min., except in emergencies or in the case of regulating batteries. When discharging at the normal rate, the discharge should never be allowed to fall below a voltage of 1.75 volts per cell. At rapid rates the discharge may be carried down to 1.60 volts per cell. If the discharge be continued after these voltages are reached, the plates may be permanently injured.

The rate of charge may be rapid when the battery is nearly or quite exhausted, but should be low when nearing the end of the charge, that is, after gassing begins. The maximum charging rate should not be greater than the two-hour rate, when the eight-hour rate is normal. Thin plates allow a more rapid charge than thick.

Each of the cells of a battery should be tested with a voltmeter and a hydrometer once a week. Where the number of cells in a battery is large, frequent inspection of each cell is impracticable. Therefore, a cell which receives the same usage as the rest is selected to serve as an indicator, and is known as a "pilot cell." Daily readings of the voltmeter, hydrometer and thermometer should be taken from this cell.

Unless a battery is properly looked after, sulphation of the injurious kind is liable to set in with the resulting shedding of active material, buckling, loss of capacity, increase of internal resistance with consequent reduction of efficiency, and increase of temperature with passage of current.

Efficiency

The efficiency varies with the rate of charge and discharge. The shorter the cycle of charge and discharge, the higher is the efficiency. Under usual conditions, the watt-hour efficiency of a battery used for storage only; that is, fully charged and subsequently fully discharged; is from 70 to 80 per cent. The larger the battery, and the higher the voltage at the end of discharge, the greater will be the efficiency. With large batteries, in which the charge is never continued very long after gassing begins and discharge is stopped at about 1.87 volts, the efficiency of storage cells may be as high as 85 per cent. A fair commercial figure is 80 per cent. for storage and 92 per cent. for regulation batteries.

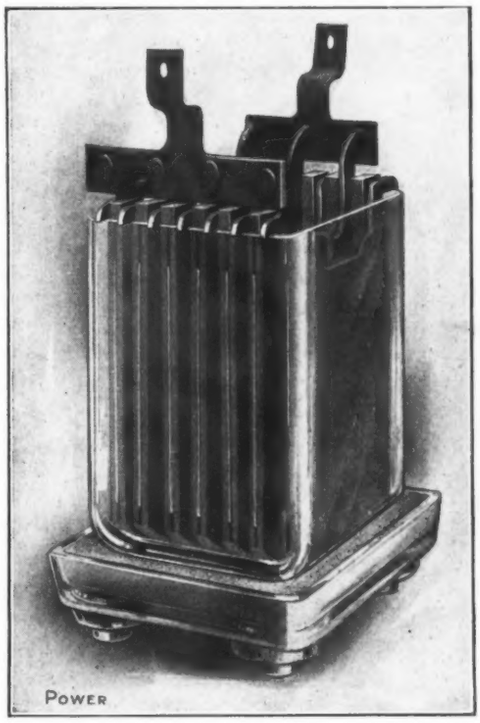

Fig. 2. Gould Battery with Glass Jar and Sand Tray

Capacity

The term "capacity" is to be understood as referring to the amount of energy in ampere-hours which may be taken out of a cell from the beginning of discharge until the voltage has decreased to 1.80 volts, when the battery is supplying current at the eight-hour rate, or to 1.68

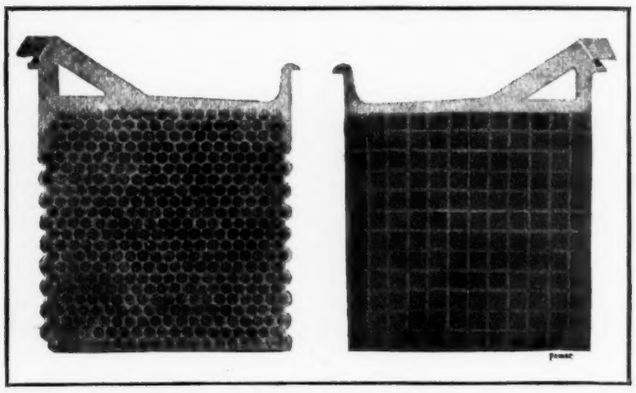

Fig. 3. "Chloride" Positive and Negative (Box Type) Plates—Electric Storage Battery Co.

volts when working at the one-hour rate, and at a temperature of 70 deg. F.

The output of a lead cell decreases with increase of discharge rate, increase of time and decrease of temperature. A loss of storage capacity may arise from loss of active material from the grid, loss of electrolyte, formation of a layer of sulphate between the grid and the active material, or from closing of the pores of the plates by impurities, sulphation or contraction.

Life

The life of a storage cell depends largely upon how closely it is worked to its rated capacity and upon its mechanical construction. High rates of charge and discharge, high working temperature, vibration, entrance of impurities into the cell, and lack of correct attention have a marked detrimental effect. The life of a pasted plate is shorter than that of the Planté type, while the life of a negative plate of either kind is from two to five times that of a positive plate of the same kind. Planté positive plates have a total life of about 1200 discharges at the eight-hour rate.

Edison Type

The basic idea of Edison's work appears to have been the elimination of sulphuric acid and the substitution of a mechanically strong material for lead. The first result of his efforts was an alkaline-cadmium-copper oxide cell, which was withdrawn from the market in 1901. After six more years of persistent investigation, he brought out the present nickel-iron-alkaline cell.

Plates

The positive plate consists of heavily nickel-plated, perforated steel tubes, arranged in rows and filled with alternate layers of nickel hydroxide and exceedingly thin flakes of pure nickel. The materials are fed in such quantities as to make layers approximately 0.01 in. in thickness for the nickel hydrate and less for the nickel flake. The tube, after being filled with active material, is reinforced with seamless steel rings, which prevent it from expanding away from and breaking contact with the contents. The tubes, after being crimped and flattened at both ends, are clamped into perfect contact with a steel frame or grid, made of cold-rolled steel and heavily nickel-plated.

The negative plate consists of a grid of nickel-plated, cold-rolled steel, holding a number of rectangular pockets filled with powdered iron oxide.

The perforated container construction prevents loss of active material by disintegration, thus doing away with sediment, internal short-circuits, and the necessity of cell washing. Moreover, the steel-nickel construction of the plates makes "buckling" impossible; even a dead short-circuit of the terminals will not affect the condition of the plates. The materials composing the plates are immune from attack by the electrolyte and thus their permanency is assured.

Separation and Insulation

The plates are separated by narrow strips of specially treated hard rubber. These strips correspond to the wood and rubber separators used in lead batteries, but unlike them are not injured by the electrolyte and need never be renewed. The end insulator is provided with grooves that take the edges of the plates, spacing them and insulating them from the steel container. At the sides of the cell, between the outside negative plates and the container, are inserted smooth sheets of hard rubber. At the bottom, the elements rest upon a hard-rubber rack or bridge, insulating the plate from the bottom of the container. The plates of the positive and negative groups are respectively fastened by nuts to horizontal steel rods integral with the positive and negative terminal pieces and distanced by steel washers.

Electrolyte

The electrolyte consists of a 21 per cent. solution of potassium hydroxide in distilled water, with a small percentage of lithium hydroxide, having a normal specific

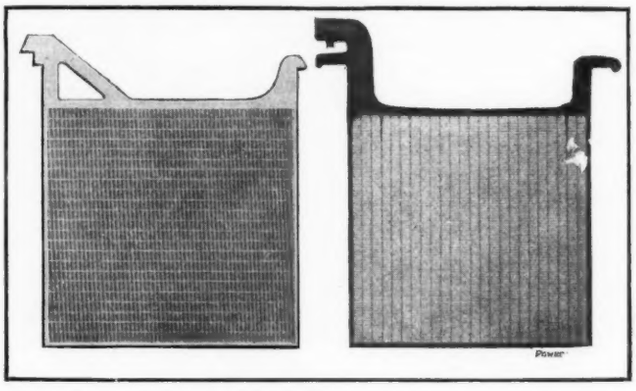

Fig. 4. "Tudor" Positive and Negative (Pasted) Plates—Electric Storage Battery Co.

gravity of about 1.200. The lithium hydroxide seems to accomplish a cementation of the positive material. In the early type where caustic potash was used alone, the positive plates deteriorated very rapidly, but when the action of the lithium hydroxide was discovered and applied, this deterioration was overcome. The electrolyte does not vary in density during charge and discharge, nor is the capacity of the battery affected materially by slight variations. In mixing the electrolyte, no special care need be exercised in order to prevent injury to the

operator, and the potash solution does not attack the steel.

Containing Cell

The rectangular container is made from cold-rolled, corrugated, nickel-plated sheet steel, welded at the seams by the autogenous method, making leakage or breakage from severe vibration impossible. The nickel protection

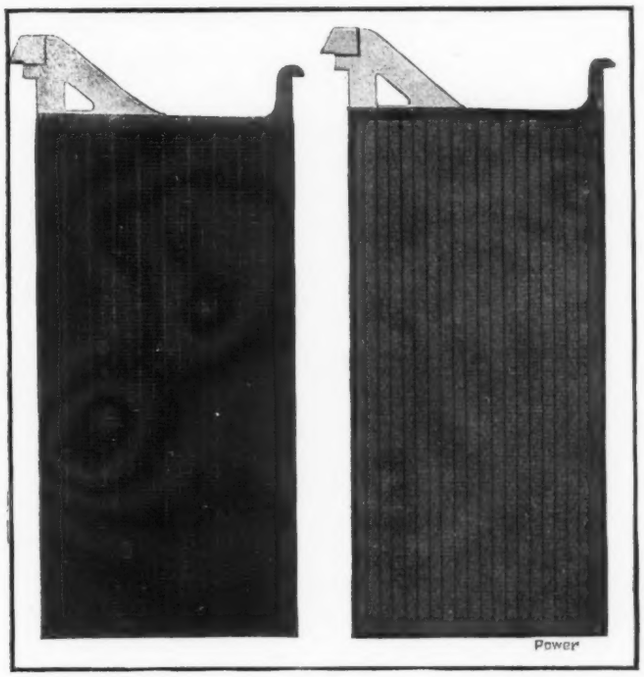

Fig. 5. Positive and Negative "Exide" Plates —Electric Storage Battery Co.

is supplemented by dipping the container in a compound which gives it a tough, yet flexible insulating coating. The cover or top is nickeled steel and is welded to the rest of the can after all parts have been assembled therein.

The cover of the early type of can had four mountings. Two of these openings were for the polepieces, a third for the separator valve, which permits the escape of gas when charging, but prevents spraying, evaporation, the spilling of the electrolyte and the entrance of impurities. The fourth opening was for the purpose of adding water to replace that carried off in charging, and was fitted with a cover that could be clamped down and made water-tight by a locking lever. The present form of cell has the separator valve inside of the filling aperture, so that there are only three perforations in the can cover.

Assembling and Mounting

The cells are assembled into a battery in strong side-suspension trays, the cells rest upon and are held firmly in place by means of steel supports known as "cradles" and "hold-downs." The weight of an Edison battery being about half that of a lead battery of the same capacity, and the former occupying a slightly smaller space, a lighter construction can be used in a battery room for the former than the latter. The Edison battery requires no fan-ventilated isolated room as no corrosive fumes are generated. The life of the containers depends upon their state of cleanliness, and if neglected they will corrode sooner or later.

The cells are electrically connected by nickel-plated copper links, swedged into lugs, which fit the tapered steel cell terminals. The lugs are drawn down and held to a tight fit by means of nickeled steel nuts, which screw on the ends of the terminals. To facilitate disconnecting, a screw jack is used to separate the lugs from the taper terminals to which they practically "freeze." Any person can connect up the cells and no skilled laborer, such as a "lead burner," is needed.

Care and Management

The care required by the Edison cell is limited to such matters as the addition of distilled water to make up for charging loss, the renewal of the electrolyte when its specific gravity is below 1.16 after a full charge, the keeping of the outside of the battery clean, and the occasional recoating of the trays with an alkali-proof paint.

It is permissible, for short periods, to discharge at any rate desired; but maximum power is developed when the current is about six times normal. Continuous discharge should not exceed 25 per cent. above normal rate. Short-circuits subject the cell to severe strains, but no injury results if the short-circuits are not consecutive and often repeated.

The ability of the Edison cell to stand short-circuits is due to its high internal resistance. The short-circuit current for the alkaline type of battery is about sixteen

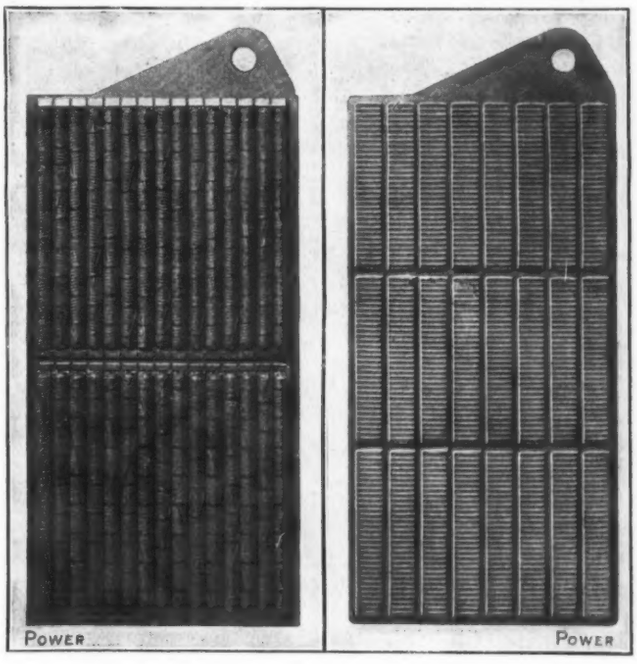

Fig. 6. Positive and Negative Plates— Edison Battery

times its normal discharge current, while that for the acid-lead type is about fifty times its normal discharge current.

Charging should never be done at less than the normal seven-hour rate, and may be boosted to high rates for brief periods so long as the temperature of the cell does not rise above 115 deg. The Edison cell can be recharged at any time, without injury, regardless of the extent of the former charge remaining. Moreover, no damage is done by long and oft-repeated overcharging. The only thing necessary when taking a cell out of commission is to

fill the cell with distilled water to ½ in. above the plates. When putting the battery in commission, the plates should be covered with electrolyte and the cell charged for 12 hr. at normal rate, after which the cell may be treated as usual. Cells have had their electrolyte boiled away and have stood empty for weeks without being injured. They regained their full capacity after being charged and discharged once. The effect of charging in a reversed direction for 15 hr. at the eight-hour rate was remedied after having subjected the cell to four cycles of charging and discharging in the normal direction.

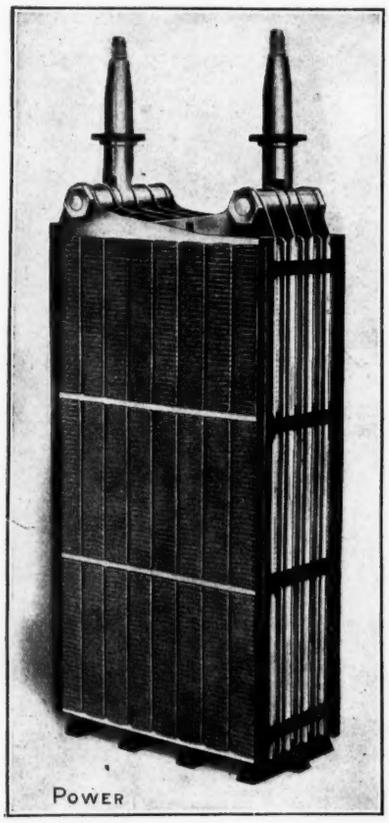

FIG. 7. ASSEMBLED PLATES OF EDISON BATTERY REMOVED FROM CONTAINER

EFFICIENCY

The efficiency of the Edison battery is lower than that of the lead cell and is necessarily so on account of the low electromotive force, about two-thirds that of the lead battery. The efficiency is much increased by partial charging as compared with normal charging. On short charges the efficiency is 95 per cent. for ampere-hours and 75 per cent. for watt-hours, while on seven-hour charges this falls to 82 per cent. for ampere-hours and 58 per cent. for watt-hours. The volt efficiency is about 72 per cent. for the usual charge. The efficiency of the Edison cell in contrast to that of the lead cell increases with use.

CAPACITY

The capacity of an Edison cell increases with use and it is guaranteed to give its full capacity for four years. The capacity of the cell varies from 13.5 to 17 watt-hours per pound of material and from 0.65 to 0.75 watt-hours per cubic inch of complete cell volume.

LIFE

Owing to the comparatively recent development of the Edison cell its ultimate life is not known definitely. Batteries, which are being tested for life under purposely imposed conditions designed to shorten their life, have developed over 1200 complete cycles of charge and discharge, and still show a capacity about 10 per cent. above their normal rating. The life of a cell is shortened by continuous working at high temperatures and high current rates, but the occasional subjection to these treatments is said to have no detrimental effect.

COST

The first cost of an Edison cell is more than that of a lead cell of equal capacity; the list price of a complete single cell being from 6 to 9c. per ampere-hour of capacity. When durability and small maintenance cost are considered, however, this difference is compensated.

CONCLUSIONS

The relative advantages and disadvantages of the two types of cell may be summarized as follows:

(1) The principal advantage of the lead cell lies in its high efficiency and low first cost.

(2) Among the innate disadvantages of the sulphuric-acid battery can be mentioned: Excessive weight; structural weakness of parts; corrosive nature of electrolyte and fumes; loss of capacity; shedding of active material; exacting and incessant care required for successful operation; fracture and buckling of plates; sulphation; internal discharge; high installation and maintenance costs.

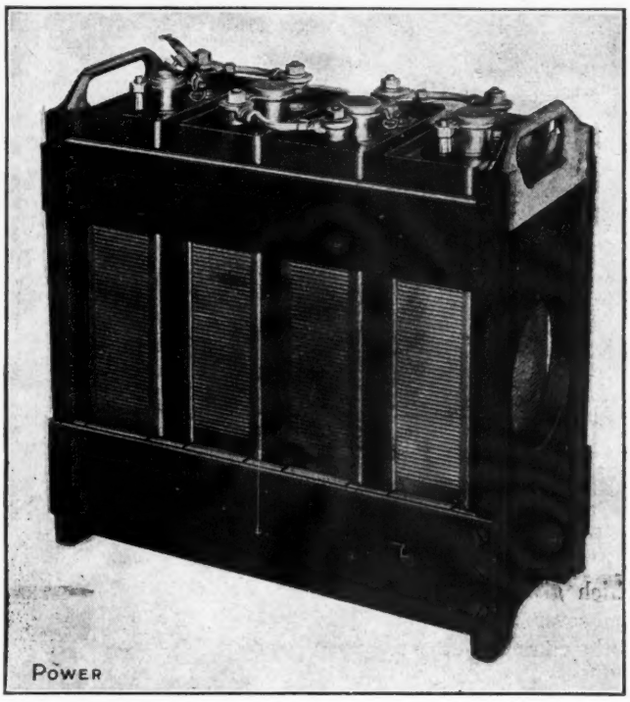

FIG. 8. ASSEMBLED CELLS IN BATTERY TRAY—EDISON TYPE

(3) The advantages of the Edison cell are: Increase of capacity with use; simplicity of the care required; ease of interconnecting the cells; steel-preserving electrolyte and lack of corrosive fumes; durability and sturdiness of cell structure; low weight per unit of capacity; ability to withstand short-circuits; absence of sulphation, buckling and sediment; immunity from injurious effects of overcharge; low maintenance cost.

(4) The disadvantages of the Edison cell may be summed up as high initial cost and comparatively low efficiency, due to low cell voltage.

It is thus evident that each type of battery has its special field, and, hence, a satisfactory selection can be made only after an exhaustive investigation of all the factors entering into an installation.

HEATING AND VENTILATION

Cost of Heating and Power-Plant Apparatus

By W. J. Downing

Several years ago the writer became convinced that the only way to obtain cost figures was to keep an accurate account of the costs of the various items in plants which came to his attention and then to work out these costs on a unit basis.

In order that engineers and owners may form an opinion as to the probable cost of a proposed system the following information is submitted: List prices of material are usually available and when possible discounts are given for standard apparatus. All prices are based on actual installations, most of them in the New England States, and allowance should be made for other localities, based on the difference in cost of labor and material.

Radiation

Radiation will be classified under five headings:

1. Cast-iron direct radiators cost 19 to 27c. per square foot of surface, depending on the height of the radiator. The labor cost will be nearly the same for casting and finishing a section containing 1 sq.ft. of surface as for a section containing 5 sq.ft.

2. Cast-iron indirect radiators of the pin type for gravity work cost 16 to 18c. per square foot.

3. Cast-iron radiators for fan systems cost 25c. per square foot.

4. Pipe coils for direct radiation cost 30c. per square foot.

5. Pipe heaters consisting of 1-in. pipes with cast-iron bases for fan systems cost 45 to 50c. per square foot of surface. For cast-iron bases with a damper for direct indirect radiators add $1.25 for each 10-in. length of base.

The labor cost for installing direct radiators on a one-pipe system can be obtained by allowing one day's time for a steam fitter and his helper for each radiator. This covers the time required to run the vertical risers and connect and set the radiators. It does not include the time required to place the horizontal mains in the basement and connect up the boilers. This item will be covered under another heading. For a two-pipe system allow 1½ days time for a fitter and helper per radiator.

Indirect radiators for gravity and fan-blast systems cost about ½c. per pound for the former and 1c. per pound for the latter for erection together with the labor cost of a fitter and helper for one day for each four connections made to the heater sections.

Allow 2½ to 3c. per square foot of surface of pipes and radiators for bronzing.

Automatic air valves cost 75c. to $1 each in place.

For temporary setting of direct radiators used to furnish heat in the building while under construction, allow $2.25 for each radiator.

Figures based on a large number of installations show that an allowance of $50 per thermostat should be made for automatic control. This includes the air piping, compressor dampers and thermostats, set in place and connected.

Boilers and Auxiliaries

Small cast-iron fire-pot boilers for house heating cost $30 to $35 per square foot of grate area.

Cast-iron sectional boilers for house and public-building heating cost $21 to $25 per square foot of grate area.

Horizontal fire-tube boilers set in place complete with trimmings ready for steam and water connections cost $12 per horsepower.

The Manning type of vertical boiler for power-plant work will cost $10 per horsepower erected.

Water-tube boilers set in place with trimmings cost $14 to $16 per horsepower.

Internally fired boilers of the Morrison type cost $16 to $18 per horsepower, including trimmings.

Dutch or extended ovens are often used in power plants for burning a low grade of fuel, or utilizing the waste material from manufactured products. These ovens will cost $250 for a 300-hp. unit.

Superheaters cost $2.25 to $3 per horsepower, depending on the size and and type.

Special boiler settings designed to economize heat, similar to the Smith setting cost about $150 per boiler.

All of the above prices are based on boilers with plain grates. Shaking grates should be figured at from $5 to $6 per square foot of surface.

Feed-water heaters of the closed type cost from 75c. to $1 per horsepower, depending on the size of the unit. Feed-water heaters and purifiers of the open type cost $2.20 per horsepower for a 100-hp. unit and $1 per horsepower for a 1000-hp. unit. Intermediate sizes cost a proportional amount.

A good damper regulator for controlling the draft in boilers can be obtained for $50.

Boiler-feed pumps cost 50c. per horsepower capacity of units of 150 to 200 hp.

Blowoff and return tanks suitable for 100 lb. pressure cost about 8c. per pound in weight.

Copper hot-water tanks good for 100 lb. pressure complete with steam coil cost about $1 per gallon capacity. Add $50 if the tank has automatic control.

Steam traps take a discount of 40 per cent. from list prices.

Pipe Fittings and Valves

While there are several large manufacturers of these products it is usually safe to figure the following discounts: Steam pipe, 75 per cent.; valves, 50 to 60 per cent.; cast-iron fittings, 70 per cent.; spiral-riveted pipe, 70 per cent.

An accurate list should be made of the actual material required for any particular installation, as there are

too many variables to use a unit price per horsepower capacity of the plant. The labor cost will average $1.50 per horsepower for connecting the boilers and installing the basement mains in plants of 200 to 400 hp.

The special valves necessary for a first-class vacuum system cost $6 to $8 per radiator. Another method of figuring vacuum systems is to allow 10c. per square foot of radiation for the special apparatus required.

Covering

An asbestos covering 4 in. thick for boilers and heaters will cost in place 50 to 60c. per square foot of surface. Air-cell covering 1 in. thick will cost 22c. per square foot. Eighty-five per cent. magnesia 1 in. thick will cost 30c. per square foot. These prices include the labor required to apply and are useful in calculating the cost of covering heating ducts and smoke flues.

Steam-pipe covering made of 85 per cent. magnesia will cost one-half of the list price, including the labor of applying. If desired the discounts applying to the various types of covering can be obtained and the labor cost based on the fact that one man will cover 100 ft. of straight pipe per day up to 4-in. diameter or will cover 40 fittings per day up to 4-in. size. The above amounts will be more for larger sizes due to the increased labor of handling.

Ventilating Apparatus

Centrifugal steel-plate fans for ordinary systems in which the total pressure does not exceed ¾ oz. will cost $10 to $13 per 1000 cu.ft. of air per min. capacity, depending on the size.

Direct-current motors for driving fans will cost $18 to $25 per horsepower. Regulating rheostats cost 60 per cent. of the list prices.

High-pressure engines for fan driving cost $10 to $16 per horsepower. Low-pressure engines for fan driving cost $18 to $22 per horsepower.

Air washers are usually based on a velocity of 500 ft. per min. and on that basis cost $18 to $26 per 1000 cu.ft. of air per min. capacity. Erection of fans, motors and air washers will cost about 1c. per pound in weight.

Galvanized-Iron and Steel-Plate Work

Piping arrangements employing galvanized-iron distributing ducts cost about 15c. per pound in place. The ratio of weight of iron to the cubic contents of the building varies widely with different types of building. In factory work where heating is the primary object the galvanized-iron ducts for an overhead system will average 1 lb. of iron to 100 to 125 cu.ft. of contents. In buildings where ventilation is the main object no standard values can be given as the amount of metal will depend on the standard of ventilation maintained. In each case the actual weight of metal must be calculated from the plans.

Steel-plate work for smoke flues costs from 6 to 8c. per pound.

Registers and Screens

Cast-iron registers for floors and side walls cost one-fourth the list price. Bronze registers cost one-half the list price. Plain wire screens with angle- or channel-iron borders cost 15 to 25c. per square foot. Allow 3c. per square foot for bronzing.

Filter screens of cheese cloth for removing dust from the air are based on a velocity of 30 to 50 ft. per min. through the net area. Their cost will be from 50 to 70c. per square foot, depending on the quality of material. Mushroom ventilators cost 65 to 75c. each.

Foundations

Allow 75c. per cubic yard for excavation in ordinary soil and $4 per cubic yard for rock. Brick foundation walls cost 40 to 50c. per cubic foot in place. Concrete foundations cost $6 to $7 per cubic yard for the concrete and 15c. per square foot of surface for the forms. Waterproofing will cost 40c. per square foot.

Sprinkler Systems

Sprinkler systems cost from $3 to $3.25 per head, including pipe, sprinkler heads and erection. Hose racks for fire protection in public buildings cost $50 each, including piping and erection.

Gas Piping

In fireproof buildings gas-pipe systems cost $5 to $6 per outlet for labor and material. For residences of the usual frame construction allow $2.50 to $3 per outlet.

Electric Lighting

Labor and material for wiring will cost about $6 per outlet. Three-light office fixtures will cost $7 each, two-light brackets $6, and one-light brackets $4. These prices are for a good, substantial fixture hung and connected.

Unit Costs

While the conditions of various installations make it impossible to give a unit price for a system that will apply in all cases the average of a large number of jobs shows some interesting results. The average cost of a heating system for dwelling houses, using direct-steam radiation is 80c. per square foot of radiation. For office and factory work allow $1 per square foot of radiation. For hot-water direct radiation allow $1.25 per square foot of radiation. To these prices should be added that of the boilers to obtain the cost of the entire system.

Although the size of direct-steam radiators varies over a wide range the cost of complete systems, exclusive of boilers, averages $37 per radiator.

All prices stated in this article are the costs to the contractor. An allowance for contractors' profit should be added to the total cost of the system. Profit is usually figured as a percentage of the total cost and will vary from 10 to 15 per cent. It will be noticed that the prices stated above give a considerable range and the question may arise as to the exact value to be used. It may be helpful to note that in any case a price should be selected depending on the size of the apparatus. For instance, a boiler with 5 sq.ft. of grate area will cost more per square foot than one with 20 sq.ft. By paying attention to the relative size of the unit in question a fair estimate can be made of the cost from the values given.

❋

A 50,000-Hp. Hydro-Electric Plant is planned to be built at Montague City, Mass., by the Turner Falls Power Co. The initial development will total 30,000 hp. and is to be completed early in 1915. The plant will cover half an acre of ground and will utilize water from a canal 1.5 miles in length, requiring the excavation of 500,000 cu.yd. of material, of which 100,000 cu.yd. will be rock excavation from a ledge 30 to 50 ft. deep.

Shunt System of Connecting Radiators

By H. A. Kieselbach

In the Oct. 7 issue, Ira N. Evans, in his calculations for the flow of water through the shunt connection illustrated in Fig. 1, makes the following statement which appears at the top of page 508: "The length of the three 1½-in. pipes in the coil in terms of 1¼-in. pipe is proportional to the areas, that is, the greater the area the shorter the length to be equivalent as far as friction is concerned." From this he finds that by multiplying the lengths of the three 1½-in. pipes, *X*, *Y* and *Z*, in Fig. 1, by the area of a 1¼-in. pipe and dividing by the combined areas of the three 1½-in. pipes, an equivalent length of 7.353 ft. of 1¼-in. pipe is obtained. Or, in other words,

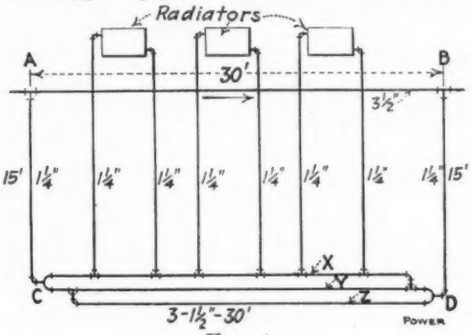

Fig. 1

the friction loss from *C* to *D* is equal to that caused by 7.353 ft. of 1¼-in. pipe and the friction of the entire shunt from *A* to *B* is equivalent to that of 37.353 ft. of 1¼-in. pipe.

The above assumption regarding equivalent lengths with respect to friction (which, by the way, does apply to electric conductors—the resistance being inversely proportional to their sectional areas) is not correct in connection with the flow of fluids through pipes, as it only takes into account the velocity of flow, which is inversely proportional to the pipe areas. The friction equation must also include the factor $\frac{V^x}{D^y}$. Take, for example, two pipes whose inside diameters are equal to D and D_1. The ratio of their sectional areas is

$$\frac{A}{A_1} = \frac{D^2}{D_1^2}$$

The ratio of velocities through these pipes when delivering equal quantities of water in unit time is

$$\frac{V}{V_1} = \frac{D_1^2}{D^2}$$

and their frictional resistances per unit of length are in the ratio of

$$\frac{F}{F_1} = \frac{\frac{V^x}{D^y}}{\frac{V_1^x}{D_1^y}} = \frac{\frac{\left(\frac{1}{D^2}\right)^x}{D^y}}{\frac{\left(\frac{1}{D_1^2}\right)^x}{D_1^y}} = \frac{\frac{D^{-2x}}{D^y}}{\frac{D_1^{-2x}}{D_1^y}} = \frac{D^{-2x} \times D^{-y}}{D_1^{-2x} \times D_1^{-y}} = \frac{D_1^{2x+y}}{D^{2x+y}}$$

Substituting 1.85 for x and 1.166 for y

$$\frac{F}{F_1} = \frac{D_1^{2 \times 1.85 + 1.166}}{D^{2 \times 1.85 + 1.166}} = \frac{D_1^{4.866}}{D^{4.866}}$$

or the frictions of two pipes of the same length passing the same quantity of water in the same unit of time are inversely proportional to the 4.866 power of their diameters.

To prove these figures, refer to Fig. 2, in which a 1¼-in. pipe 30 ft. long is connected in series with a 1½-in. pipe of the same length. The quantity of water flowing through them is such that the velocity in the 1¼-in. pipe is 4 ft. per sec. The area of the 1¼-in. pipe is 1.5 sq.in. and that of the 1½-in. pipe is 2.04 sq.in. Therefore, the rate of flow in the 1½-in. pipe will be

$$4 \times \frac{1.5}{2.04} = 2.94 \textit{ ft. per sec.}$$

Using the formula

$$h = l \times 0.00037 \frac{V^{1.85}}{D^{1.166}}$$

in which

h = Friction loss in feet;
l = Length of pipe in feet;
V = Velocity of flow in feet per second;
D = Internal diameter of pipe in feet.

We find the frictions of the two pipes to be as follows: For the 1¼-in. pipe,

$$h = 30 \times 0.00037 \times \frac{4^{1.85}}{0.115^{1.166}} = 1.796 \textit{ ft.}$$

For the 1½-in. pipe,

$$h = 30 \times 0.00037 \times \frac{2.94^{1.85}}{0.134^{1.166}} = 0.8503 \textit{ ft.}$$

Now comparing these friction heads, it will be found that the loss of head in the 1¼-in. pipe bears a ratio to that in the 1½-in. pipe of

$$\frac{1.796}{0.8503} = 2.112$$

or the loss of head in the 1¼-in. pipe is 2.112 times that in the 1½-in. pipe with equal quantity of flow.

The internal diameter of the 1¼-in. pipe is 1.38 in.

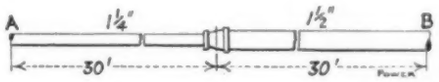

Fig. 2

and that of the 1½-in. pipe is 1.61 in. Substituting these diameters in the equation:

$$\frac{\textit{Friction of } 1\frac{1}{4}\textit{-in. pipe}}{\textit{Friction of } 1\frac{1}{2}\textit{-in. pipe}} = \frac{1.61^{4.866}}{1.38^{4.866}} = 2.117$$

This result checks with the figure 2.112, derived from the actual calculations for the friction losses to the third figure, which is as close as possible with the values of the pipe diameters and areas used in deriving the results.

Having found that the frictions of two pipes are inversely proportional to the 4.866 power of this diameter, it also follows that the lineal feet of pipe required for a given friction under a given quantity of flow will be directly proportional to the 4.866 power of the diameter.

For example, in Fig. 2 the lineal feet of 1½-in. pipe equivalent in friction to 30 ft. of 1¼-in. pipe will be

$$30 \times \frac{1.61^{4.866}}{1.38^{4.866}} = 30 \times 2.117 = 63.51 \textit{ ft.}$$

and the equivalent of 30 ft. of 1½-in. pipe in terms of 1¼-in. pipe will be

$$30 \times \frac{1.38^{4.866}}{1.61^{4.866}} = 30 \times \frac{1}{2.117} = 14.17 \text{ ft.}$$

The friction from A to B in terms of 1½-in. pipe will be

$$30 + 63.51 = 93.51 \text{ ft.}$$

and in terms of 1¼-in. pipe

$$30 + 14.17 = 44.17 \text{ ft.}$$

According to the rule given by Mr. Evans, the friction from A to B in terms of 1¼-in. pipe would be 52.06 ft., giving a value of the 1½-in. pipe in terms of 1¼-in. pipe about 50 per cent. too high.

The reason Mr. Evans' values of friction in the main and the shunt check the velocities derived by direct calculation is that the factor 37.353 ft. for equivalent length of shunt is used both in the calculation and the check, thereby introducing the same error in each.

In Fig. 1, assume that each of the 1½-in. pipes carries one-third the quantity of water passing through the 1¼-in. branches to the main. Strictly speaking, this is not true, but will answer for the present case.

To determine the length of 1¼-in. pipe equivalent to the three 1½-in. pipes, imagine first that two of the 1½-in. pipes, X and Y, are cut out of the circuit so that the remaining pipe Z will carry the full flow. From previous calculations we find that the resistance of Z will be equal to 14.17 ft. of 1¼-in. pipe. Now connect X and Y into the circuit and the velocity of flow in X, Y and Z becomes one-third of that which existed in Z alone and the friction through X, Y and Z falls to $(\frac{1}{3})^{1.85}$ of its original value in Z and the equivalent length of the three pipes in terms of 1¼-in. pipe becomes

$$14.17 \times \frac{1}{3^{1.85}} = \frac{14.17}{7.633} = 1.86 \text{ ft.}$$

On the basis of sectional areas, the equivalent length of 1¼-in. pipe is 7.353 or 400 per cent. too high.

Adding the equivalent of the three 1½-in. pipes to the actual length of 1¼-in. pipe in the shunt, we have

$$1.86 + 30 = 31.86 \text{ ft.}$$

which is the equivalent length of the entire shunt (neglecting the effect of fittings, valves, etc.) in terms of 1¼-in. pipe.

The equivalent of 31.86 ft. of 1¼-in. pipe in terms of 3½-in. pipe is

$$31.86 \times \frac{3.548^{4.866}}{1.38^{4.866}} = 3153.57 \text{ ft.}$$

Let

Q = Volume of flow through the shunt ;
Q_1 = Volume of flow through the shunted portion of the 3½-in. main;
h = Loss of head from A to B—equal for both main and shunt;
K = A factor.

$$Kh = 30 \times Q_1^{1.85} = 3153.57 \times Q^{1.85}$$

$$Q_1^{1.85} = 105.12 \times Q^{1.85}$$

$$Q_1 = 12.382\ Q$$

or the volume of flow in the shunted portion of the main will be 12.382 times that in the shunt.

Taking Mr. Evans' value of 6 ft. per sec. as the velocity of flow in the main outside of the shunt, we have

$$6 \times 3600 \times 0.0687 \times 60 = 89{,}035 \text{ lb. per hr.}$$

as the quantity of flow in the 3½-in. main outside of the shunt. The flow in the shunt will, therefore, be

$$89{,}035 \times \frac{1}{12.382 + 1} = \frac{89{,}035}{13.382} = 6653 \text{ lb. per hr.}$$

with a velocity in the 1¼-in. pipe of

$$\frac{6653}{3600 \times 0.01039 \times 60} = 2.965 \text{ ft. per sec.}$$

The velocity of flow in the shunted section of the 3½-in. main will be

$$6 \times \frac{89{,}035 - 6653}{89{,}035} = 5.55 \text{ ft. per sec.}$$

Checking these results it will be found that the friction of 30 ft. of 3½-in. pipe with a velocity of 5.55 ft. per sec. is

$$30 \times 0.00037 \times \frac{5.55^{1.85}}{0.296^{1.166}} = 1.098 \text{ ft.}$$

In the shunt, the friction of 31.86 ft. equivalent length of 1¼-in. pipe with a velocity of 2.965 ft. per sec. is

$$31.86 \times 0.00037 \times \frac{2.965^{1.85}}{0.115^{1.166}} = 1.096 \text{ ft.}$$

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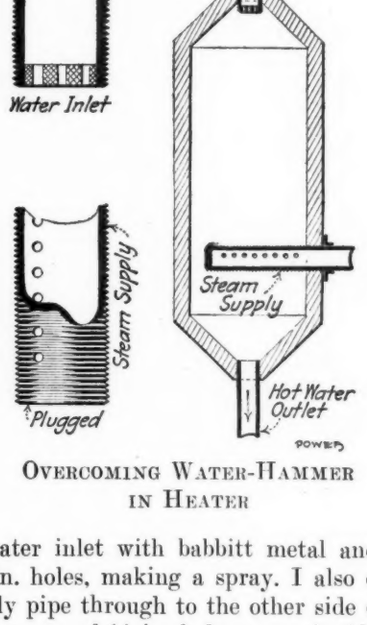
Hot-Water-Heater Trouble

A few years ago I made a small water heater like the one L. N. Webster described in the issue of Sept. 9, and had the same trouble with water-hammer. This hammer is caused by the water level being above the steam inlet, causing excessive boiling. This I remedied by plug-



OVERCOMING WATER-HAMMER IN HEATER

ging the water inlet with babbitt metal and drilling it full of ⅛-in. holes, making a spray. I also extended the steam-supply pipe through to the other side of the heater and drilled a row of ⅛-in. holes on each side. I opened the hot-water outlet wide and regulated the supply by the cold-water valve. This did away with all vibration and gave me a good supply of hot water.

C. R. VAN KEUREN.

Famoso, Calif.

EDITORIALS

Riveted Piston Rods

To their credit designers and constructors usually allow a liberal factor of safety for parts of engines and boilers that are obviously subject to great stresses, especially where there is doubt of the efficiency of the design. Very ordinary experience should inform a constructor that cold riveting of metals is severe abuse very likely to start their disintegration. Yet many reputable engine manufacturers, for no better object than economy of time and material, depend on this crude method of securing engine piston rods to pistons of considerable size. The form and strength of riveting of a piston rod are not open to ordinary inspection and have to be taken largely on faith.

A failure of a piston-rod riveting is described on page 735 of this issue. It appears that the rod end was flanged so thin that the "mushy" texture which riveting had imparted to the metal permitted the riveted end to be drawn out into cup form, resulting in the release of the hold of the piston rod.

The incident brings strongly to mind the question whether disintegration due to cold riveting is not so likely to result in failure that the practice should be abandoned for this important detail of engine construction. Failures of this kind have doubtless resulted in serious accidents that have been attributed to unknown causes or to the negligence of operating engineers, when in fact they have been due to imperfection of material, workmanship or design beyond possibility of his inspection.

❋

Fixing the Blame

"Who was to blame?"

The evasiveness of some answers to this inquiry when it concerns a boiler accident would be amusing if it were not such a serious question. The coroner usually blames the engineer, perhaps because the latter was killed, and therefore cannot defend himself. The boiler builder may hold the plant owner responsible, because of negligent usage. In turn, the owner may shift the blame to the engineer, who then claims, if he escapes the wreckage, that the owner refused to make needed repairs or buy new equipment. Perhaps the boiler inspector lapsed in vigilance, the boiler laws are inadequate, or what is most culpable, not to say criminal, that particular state has no boiler laws!

In June, 1912, an engineer was killed in a boiler accident in British Columbia. The law in that section required that studs and check-nuts be placed on slip-expansion joints. The inspector knew of the lack of this requirement, but took a chance. He surely was guilty of contributary negligence. Of what use is the law if its sworn servants fail to carry out its behests?

If heed had been given the insurance company's recommendations, a recent and much more serious explosion would in all probability have been prevented. The plant owners refused to listen, and the insuring company had no recourse other than to cancel the risk.

This instance illustrates the great need of a state court or board to which insurance inspectors could report all dangerous conditions and laxities. Then this body, after verifying the reported conditions, should have the power to force the owner either to make safe his equipment within a reasonable time or to shut down the plant until he did. Insurance companies are usually thorough and painstaking because they assume monetary risks, but the plant owners, in addition to property damage, risk human life.

All of us most willingly agree that boiler accidents are altogether too frequent; that their primary cause is criminal negligence in most instances; that "something must be done at once"—and then we promptly lapse back into the rut until the next accident arouses our indignation.

We babble over eternal vigilance in the engine and boiler room, the responsibilities of owners and managers, the frequent inspections, the safety of human life and the preservation of property, but just when are we going to adopt all these very commendable precautions?

❋

The Victories of Peace

History as it is written and as it is taught is one great panorama of wars and dynasties. It bristles with the names of doughty warriors and rulers, describes at length their struggles and achievements, and dismisses the inventors and promoters of the great agencies which have made modern civilization possible, with scanty, if any, mention.

The invention of printing has had more influence upon the development of the race than any act of any ruler that the world has ever known; and more than half of those who read this will not know the inventor's name.

The men who invented and developed the steam engine did more to lighten human toil and to make possible to each of the dwellers upon earth a larger mead of comfort and enjoyment than all the generals who ever pitted men against their fellows. Hunt for their names in the indexes of your histories.

Art and literature have been broad highways to fame. The high-school scholar can tell you who wrote what, and when he wrote it, but ask him who built the first railroad in America, and when and where it was. The magnificent Albert Memorial is covered with the names of authors and painters and sculptors, but Michael Angelo is there because he was an artist, not because he was an architect, and Leonardo Da Vinci because he was a painter, and not because he was an engineer. Something of the spirit of contempt for the utilitarian which led Seneca to vehemently labor to clear Democritus from the imputation of having made the first arch, and

Anacharsis from the charge of having contrived the potter's wheel, is still extant. The world has still something of the feeling toward the engineer that society has for the man who is "in trade."

Have you noticed how many engineers and inventors and captains of industry have been presidents, or have even filled places of lesser importance in the conduct of the country's affairs?

The land is full of libraries which conserve the writings of those who have thought, dreamed, imagined and studied for the benefit of others, and it is well that it should be so. Every city of importance has its art museum where the visions of others expressed in different media are selected and exhibited at enormous expense, and they are good to see and to know. There are numerous museums of natural history where one may study anything from a pterodactyl to a house fly. The natural-history exhibit of the Smithsonian Institution is housed in a magnificent $3,500,000 building, but the poor little fragmentary relics of the industrial development of the country are tucked away in corners of the old one-story building, many of which are offered or could be had for the housing are necessarily refused or ignored, and industrial history is fading with the memory of those who see it made.

Peace hath her victories no less than war, and the time is ripe for a proper recognition of the men who win them, and an adequate record of the manner of their winning.

Flatbush Gas-Electric Plant

The condenser system in operation at the plant of the Flatbush Gas Co., which plant is described in this issue, deserves the serious consideration of consulting and gas works engineers particularly.

With practically no increase in installation save a few lengths of pipe, the engineers of the plant have succeeded in utilizing the water-seal troughs of a large gas holder for a storage reservoir for condenser-circulating water. The heat of this water as it comes from the condensers keeps it from freezing, thus dispensing with about one hundred boiler horsepower formerly required for such service. The decrease in coal consumption is nearly net gain because the vacuum on the turbines is increased about two inches over what was possible with the use of cooling towers alone.

This is the first time to our knowledge that such an application has been made of condenser-circulating water. The plan is applicable to any combined gas holder and electric station, and should prove advantageous in many gas-generating plants where the gas-blower engines are the only principal units. Usually these engines are quite large and are run noncondensing, while live steam is used to keep the holder water seals warm in winter.

The use of boiler-feed water for heating purposes has long been recognized as ideal where building sizes permit. The installation at Flatbush is indeed a convincing example of the success of this system.

Same Old Carbonine

On page 730 of the present issue will be found a letter from one of our subscribes describing theatrical methods of parading Carbonine before the good people of an old New England town. Readers of POWER will doubtless remember our "repudiation" and challenge of a furnace medicine of the same name, published on page 691, Nov. 15, 1912, issue. That challenge to the American Carbonine Co. to substantiate its claims has never been accepted, and in view of the information furnished by our correspondent we are led to repeat: "If Carbonine is only another of the various nostrums which have been bobbing up from time to time for the past twenty, thirty or more years for the same purpose, exploited in the same way, and failing to sustain the test of real investigation and continued use, it is right that the public should know it."

The statements of our correspondent are sufficient exposition of reasons why our challenge has never been accepted and may explain why the field of Carbonine's commercial activity appears to have been shifted from the power plant to the kitchen. Combustion of coal is a broad science and frugal housewives, who may admit that they can be taught a thing or two in this branch of domestic economy, should not be discouraged from consulting these coal doctors, even though the medicine prescribed may consist only of bread pills; but the wise power-plant owner asks only for results and will continue to demand *quid pro quo*.

Civil Service Examinations

Among the institutions of our government, federal, state and municipal, the civil-service commission is a factor for much good. In many places, the commission could, perhaps, be made more efficient if less political influence were used, but the commission itself deserves commendation.

We repeat this evident statement of fact because so many engineers and firemen who are not so successful in civil-service examinations as they anticipated, condemn the commission and everything allied with it. Unfortunately it is true that men are "slated" for positions in reward for political assistance given, and despite the formality of a civil-service examination and the fact that they receive a lesser number of points than other competitors, they get the jobs. That is the outcome of the spoils systems, the vitality of which, we hope, will diminish in proportion to the growing manifestation of the ideal in government.

Engineers, individually or collectively through organizations, pay too little heed to the civil-service commission and the examinations given to applicants for positions in municipally- or state-owned plants. How much better it would be for engineers who belong to engineering organizations to attack collectively unfairness in appointments, instead of each emitting a growl of individual protest. And how much more fruitful of real results would it be for them to organize classes within the organization, each class headed by a live member as teacher, and prepare for the examinations that are held at intervals, instead of each striving individually. Individuality will not thus be lost, but will be made more manifest.

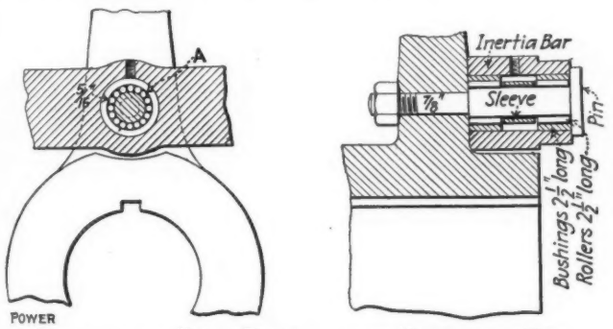
There is nothing to lose by such a plan; there is everything to gain. Even though an applicant never is fortunate enough to get a civil-service job, he has, nevertheless, been bettered by study and stimulated to action that must eventually bring results. The satisfaction of having been tested, as it were, is felt to be worth while by many who do not look for appointments.

READERS WITH SOMETHING TO SAY

Correcting Trouble of Inertia Governor

We have experienced trouble from racing of our high- and medium-speed engines. The several engines in the plant are of the same make and, although of different sizes and style of valves, they have inertia governors, all of the same make. This governor is here shown in part. The length of the inertia bar is about two-thirds the diameter of the wheel; it is of the usual construction, having one light and one heavy end, and is pivoted on a roller-bearing pin in one of the spokes. The steam eccentric is clamped to the finished hub of the bar and swings across the shaft as the bar moves.

After one of the engines had been in use for about a year the voltage became very unsteady at the usual load. Sometimes before switching the load to another generator it was necessary to partly close the throttle to prevent the speed from becoming dangerously high when the load



DETAILS OF BALL-BEARING FOR GOVERNOR PIN

went off, as the governor would "stick." The cause of the trouble was located in the governor.

The inertia bar is bored and fitted with a hardened-steel bushing. The length of the bearing is 7 in., but two bushings, each 2½ in. long, were used, leaving a space 2 in. wide in the center, as shown in the sectional view. There are two sets of rollers $\frac{5}{16}$ in. in diameter and 2½ in. long. A sleeve 2 in. long having an outside diameter of $\frac{1}{16}$ in. less than the inside diameter of the bushing, and an inside diameter of $\frac{1}{16}$ greater than the pin, was placed between the two bushings to keep the two sets of rollers in place. Grease is fed to the center of the arm, and works toward the ends.

The first pins were case-hardened and made a very tight fit in the hub. The rollers gave a sensitive bearing when new, as there was very little friction, but the strain all came on one side of the pin and bushing at about one-quarter of the circumference of the pin or at the point marked *A*. After about a year's use the inertia bar was taken off and the bearing examined. This was quite a job as the steam and exhaust eccentrics must be taken off to get to the inertia bar pin. Then the pin fitted the wheel so tightly that a jack had to be made to pull it out, even then the threads of the ⅞-in. draw bolts were nearly stripped, and a sledge was used as much as possible in the limited space in order to start the pin. After it was out it was found that the rollers had worn spots into the bushing and pin. This caused the bar to stick, and caused the racing. In making new pins the engine builder who was to furnish them was consulted, and it was decided to make them and the bushings harder, and an easy tapping fit instead of a sledge-hammer fit; also, that there was to be one set of rollers the full length of the pin instead of two short sets as before. This would increase the bearing surface from 5 to 7 in. and give a harder surface. The fault with the short rollers seemed to be that they got caught in some way, and some sets seemed to be twisted in the bearing. Some of the rollers had flat spots on them, and some of the spots on the pin were not parallel to the center line of the pin. The pins and bushings in all the engines have been changed as the action of the governor made it necessary, and some of them have been in use over two years without giving any trouble from racing. I believe one trouble with the short rolls was that the bushings were not exactly in line and true.

Instead of feeding the grease in one place as was done with the old bearings it is now fed into a circular channel in the outside of the bushing, and reaches the rollers at about the middle of their length, and in three equidistant points on the circumference.

J. C. HAWKINS.

Hyattsville, Md.

Cause of Knock in Pumps

Referring to John F. Hurst's statement in the Sept. 16 issue, page 404, concerning the reason why a pump will knock or give a short jerk, when it starts on its return stroke, my idea is that it is due to the pump not getting enough water to fill the cylinder before the plunger starts on its next stroke. The cause of the water supply being too small for the pump may be one of the following three:

(1) The water may be so low in the supply tank that the end of the suction pipe is exposed to the atmosphere, admitting air to the pump instead of water, or preventing a sufficient amount of water to reach the pump. When this is the case water and air are both drawn into the suction end of the pump, the air being compressible. The pressure is very much lower in the cylinder until the air is compressed to the working pressure of the pump. The plunger travels much faster at the beginning of its stroke until this air is compressed to the normal working pressure, which checks the speed of the plunger.

(2) The feed (suction) pipe valve may not be opened enough or the pipe may be partly clogged, due to the sediment in the water. If this is the case the water cannot get into the cylinder fast enough to fill the space in the cylinder before the plunger starts on its return stroke, thus causing a partial vacuum in the suction end of the pump, which would jerk the plunger back against the water as soon as the steam is released.

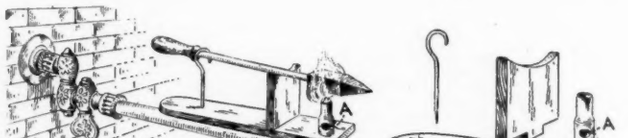
(3) The suction pipe may be too small. This would have the same effect on the plunger as the above trouble; if the springs were too weak to force the suction valves on their seat, this short jerking or kicking motion would result and continue until the spring or springs were replaced with stronger ones.

I have had trouble with pumps knocking or short jerking quite often, but I always found the causes to be the ones here mentioned.

Chicago, Ill. JOHN FERGUSON.

Heating Soldering Iron by Gas

The illustration shows an attachment for an ordinary gas fixture used to heat soldering irons. I have one of these in my engine room and it gives satisfactory service.



APPLICATION OF ATTACHMENT

Little explanation is necessary as the sketch shows clearly how the attachment is made and assembled. The burner may be one from a mantle light or an ordinary burner with a hole *A* cut in the side to admit air for making a blue flame.

Roxbury, Mass. CHARLES GUNN.

Soda Ash for Boiler Waters

I have read with interest the abstract from a lecture by Charles H. Bromley on "Soda Ash for Boiler Waters," appearing in the Sept. 16 issue.

As I understand it, the purpose of the article is to prove that solutions of soda ash (sodium carbonate) will prevent any boiler from corroding with any water for any length of time if its concentration is maintained at or over 3 per cent. normal strength.

To prove this contention, the lecturer cites one example and from this one example sets forth a general principle, applicable to all waters and all conditions. The statement attributed to Heyn and Bauer, that dilute solutions of sodium and potassium carbonate promote corrosion instead of stopping it, is given without reference.

Regarding the corrosion on the ship "New Jersey," using a dilute solution of soda ash as compared with no corrosion on the "Oregon," from a scientific standpoint, would it not have been advisable to have proved that a strong solution would prevent corrosion on the "New Jersey," even in the boilers had to be run with difficulty?

In the writer's opinion, an article of this kind does a great deal of harm, since there is little question of its main contention being erroneous when stated as a general fact. There are waters wherein the use of soda ash directly in the boiler, may result in corrosion of the boiler and of the steam piping, but such waters are not the general rule and soda ash not the primary cause.

Soda ash is being used, under almost every conceivable condition, in extremely dilute solutions in thousands of boilers all over the United States. The cases where soda ash is charged with causing corrosion are extremely rare, and an investigation of these cases will show that there is abundant cause for corrosion from other sources.*

The writer's experiences with the use of soda ash in waters from which all the free and half-bound carbonic acid (CO_2) has been removed, covers about 500 different boiler plants, ranging in size from 500 hp. to 37,500 hp., with almost every type of boiler. He has yet to find a single case of corrosion in this number of boiler plants in any part of the feed lines, boilers or steam piping. The strength of the soda-ash solution in the boiler-feed water is rarely over one or two grains per U. S. gallon, and not over 500 grains as a maximum in the water after concentration in the boiler.

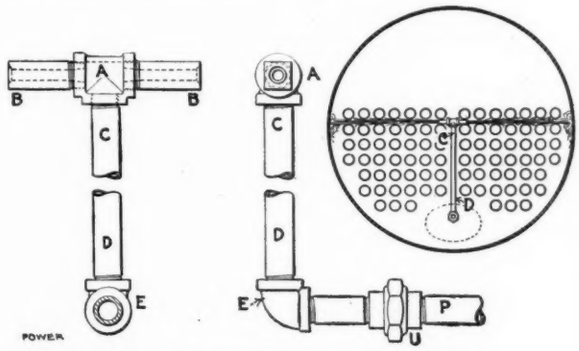
Soda ash is not a "cure-all" and is not a proper reagent to be introduced into the boiler under all conditions, but when properly used in the purification of water does inhibit corrosion.

J. C. W. GRETH.

Pittsburgh, Penn.

Nozzle for Washing Boilers

Mr. Bornmann's article on washing boilers was very interesting and the device that he uses is a good one. There is one change, however, which I think would be an improvement on the device, and that is to use a swivel joint at *E* (his Fig. 1) instead of a rigid ell. Two



NOZZLE FOR WASHING BOILERS

ells would do, but a swivel joint that could be fixed in any desired position would be better. By this means the pipe *C* would not have to be changed, as the pipes *C* and *P* could be turned to a greater angle than 90 deg., which would be practically the same as using a shorter pipe. This would permit its use on the lower rows of tubes as well as the upper rows, and, although it would not come back as close to the front head, this space could be washed by turning the nozzle sideways as far as the manhole would allow, and also by water running down from the upper rows of tubes. I should also use a round steel nozzle instead of a square one for the reason that while the square one will have a scraping action on the tops of

Previous discussion of this subject appeared in the issues of Sept. 30, p. 481, and Oct. 28, p. 613.

*[Mr. Greth's statement that "cases where soda ash is charged with causing corrosion are extremely rare," is interesting, for many of those who have used it have experienced corrosion troubles which they attributed to the presence of the soda ash. Discussion of this matter would be welcomed.—Editor.]

the two center rows of tubes there are many boilers in which the tubes are spaced so close together vertically and sometimes they are warped so that there would be a possibility that the square nozzle when turned at an angle would bind on the tubes while a round nozzle would not, and would have the same scraping action as a square one.

J. C. HAWKINS.

Hyattsville, Md.

Says Bucket Traps Are Best

In our plant there are many steam traps of various types, including those of the expansion, drip and bucket type. After going very closely into the matter, I find that the bucket type undoubtedly is superior, both as to reliability, steam consumption and in getting rid of water. Its cost for maintenance is less than with other types.

The chief trouble with the expansion trap is that the metal parts seem to alter in length after being subjected to working conditions for a few months. This lengthening or shrinkage of parts alters the adjustments, and trouble usually follows. When these traps are not set to cut off quite tightly the seat is soon cut, thereby establishing a perpetual leak until the valve is reground.

With the bucket-type trap, unless dirt has got under the seat, there are only two positions in which it is possible for the valve to stop, either full open or closed. Again, with this type of trap, steam never blows through with the discharge unless the bucket is rubbing or becomes tight on its trunnion or hinge.

In one particular instance by the introduction of bucket traps and the removal of expansion traps it is expected that enough will be saved in nine months to pay for the change.

E. R. PEARCE.

Rochdale, Eng.

Safety-Valve Problem for Discussion

An experience with a lever safety valve which would blow wide open has interested me considerably. The valve had a flat disk and was set to blow at 15 lb. It worked all right until it had lifted about $\frac{3}{16}$ in., when it moved suddenly to a wide-open position. Later, I experimented with other valves, holding them down until the pressure had increased 2 or 3 lb. above that at which they operated, then letting them go, when they would lift as high as I would allow.

It is shown in textbooks on the mechanics of fluids in motion that the force of a stream impinging on a flat surface larger than the stream is twice as great as the head corresponding to the velocity of the stream. In other words, if the end of a nozzle be covered with a flat plate and the pressure necessary to hold it there be determined and then it be moved away from the end far enough for the issuing stream to attain its highest velocity and the pressure exerted upon it be again determined; it will be found that the pressure has been nearly doubled and would be doubled if it were not for the frictional resistance upon the stream offered by the nozzle. Of course, the plate must be large enough to arrest the motion of the entire stream or the pressure will be less.

I think that in the case of the safety valve, after it has lifted a certain distance, the vertical velocity of the steam becomes great enough to slightly increase the pressure upon the disk. This increase would only have to be slight as the resistance of a lever valve remains constant as the disk is lifted, whereas the resistance of a spring-loaded valve increases.

But what I am most interested in is how likely is this to happen in practice. If readers have had similar experiences, I would like to hear from them through POWER.

Such an accident might prove serious or, at least, alarming, especially at high pressures, for the lift of a safety valve is ordinarily $\frac{1}{8}$ in. or less and when it opens an inch or more, the rate of evaporation is enormous and the water is thrown against the top of the shell with more or less force.

H. H. HASTINGS.

St. Louis, Mo.

Damage by Water in Engine Cylinders

The article on the above subject which related the experiments of H. Bollinckx was read with interest. Despite the positive statement made as to the improbability of water doing damage after it gets into the engine cylinder, and the fact that the experimental engine was "stuffed" with water from a pump provided for that purpose and suffered no serious injury, one finds it difficult to even force himself to agree with the argument.

I think it possible in some cases for water to return to the cylinder from the exhaust pipe, but the danger from this source is slight, for the valves operate wrongly to make much of a pump of the engine with the exhaust pipe for the intake. Whatever water follows the piston from the exhaust pipe must leak by a closed exhaust valve, but as valves will lift considerably on some engines it is possible that enough might get into the cylinder and get caught after the exhaust valve closed on the return stroke to more than fill the clearance space, in which case damage would result. I do not doubt that an engine can be so adjusted (with exhaust remaining open to extreme end of stroke) so that water from any source will do little or no damage, but with the usual adjustment with more or less compression, a slug of water, either from the exhaust or steam pipe is sure to do damage if more than enough to fill the clearance remains in the cylinder up to the time exhaust completely closes. As water has a velocity much lower than steam at the same pressure, it is likely to get out last.

My experience with water in engine cylinders teaches me that no chances should be taken in ordinary engine-room practice despite the assuring tone of the article referred to.

L. JOHNSON.

Exeter, N. H.

A Dangerous Mistake

A boiler having been cleaned and repaired, was being filled preparatory to being put in service.

After waiting the usual time for the water to make its appearance in the gage-glass, the attendants became apprehensive. As the water still failed to show, the boiler commenced to overflow from the open safety valve. No water was visible in the glass. It was then remembered

that a steam fitter had had the water column down repairing it. The water was run out of the blowoff to a point below the bottom flange on the column.

The gasket was removed, and, as surmised, the center had not been cut out. The column was connected and after filling, the boiler was fired up. Upon attempting to test the column by blowing down, it was discovered that there was no circulation in the column. The glass appearing to be full all the time. That the glass was not giving a correct reading was discovered by using the try-cocks. The boiler was cooled off and again emptied when it was found that the same mistake had been made with the gasket at the top of the column.

This is a dangerous mistake as the pressure was all from the bottom of the glass, it would stand full regardless of the true water level inside the boiler.

EDWARD T. BINNS.

Philadelphia, Penn.

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Carbonine

The American Carbonine Co. has established a manufacturing and distributing agency in Lynn, Mass., and with placarded automobiles and a propaganda of advertising is assisting the conservation of coal movement to the best of its ability. The concern claims that a saving of from 25 to 33 per cent. can be effected with coal treated with Carbonine when used according to directions, although this apparently exorbitant claim should easily be substantiated—if the directions are followed to the letter. The directions for household use state that "one teaspoonful of Carbonine is to be dissolved in a cup of *hot* water and sprinkled on coal in hod." Then, "Be sure and use one-third less coal and less draft." Simple, isn't it?

With the purpose of acquainting himself with facts available the writer visited the salesroom of the company where information was freely given. No steam plants were said to be using Carbonine in the vicinity, but a test was conducted at one of the large factory plants about one year ago and a saving of 25 per cent. was claimed, though, strange to say, no Carbonine has been used at this plant since making the test. Furnished with a copy of the report of the test I visited the plant where further information as to the monthly statement of coal consumed together with the corresponding readings of the feed-water meter was obtained.

Following is the report of the test as issued by the Carbonine company:

Treated Coal Nov. 1–15, 1912		Untreated Coal Dec. 1–15, 1912	
Coal, soft	81,945	Coal, soft	132,030
Screenings	81,945	Screenings	66,085
Total	163,890	Total	198,045
Hours run	60	Hours run	60
Av. hp. per hr.	476	Av. hp. per hr.	467
Lb. per hp. per hr.	2.24+	Lb. per hp. per hr.	3+
Daily coal lb.	12,807	Daily coal lb.	15,234
Water lb.	114,010	Water, lb.	125,780
Av. temp.	0.35	Av. temp.	0.33
Cost	$256.06	Cost	$340.73

While discussing the results shown by the report, the engineer who conducted the test admitted that 2.24 lb. of coal per horsepower-hour, representing a water consumption, based on the daily coal and water data in the treated coal report, of less than 20 lb. per horsepower-hour, is "a little lower than is generally considered possible for a 24x48, high-pressure engine performance." The discussion finally led to the admission that the figures were simply rough estimates which, of course, nullifies the comparative value of any information which the report might be expected to impart.

The items marked "daily coal" and "water" are said to be "fairly accurate" weighings and reading of the feed-water meter for one 10-hr. run. Computing from these values it is ascertained that the evaporation with coal treated with Carbonine was 8.90 lb. of water per pound of coal; while with untreated coal, though the mixture was 2 of coal to 1 of screenings, the evaporation was 8.25 lb. of water per pound of coal.

These figures appear to indicate a saving due, perhaps, to the Carbonine treatment. However, a comparison with the coal and water records for three months, when approximately the same mixture of coal and screenings was used, shows evaporative values during two months greater than is accredited to the Carbonine-treated coal.

Months	June	July	August
Coal, soft	118,620	107,150	121,415
Screenings	111,660	132,960	152,890
Totals	230,280	240,110	274,305
Water (cu.ft.)	32,150	35,650	39,500
Actual evaporation per lb. of coal	8.7	9.27	9

At another steam plant where Carbonine was tried the engineer thinks that there was a slight saving in favor of Carbonine, though if the Carbonine had to be purchased, the cost would have exceeded the saving observed.

At a city plant where apparatus is installed for conducting fuel tests, Carbonine was tried for one week. Figures of these tests are not available, but the chief-engineer's statement that "so far as could be ascertained the treatment of Carbonine made no difference in the results obtained" coincides with the views cited above.

Apparently, there is a market for Carbonine in the "home combustion" field as it is no secret that about 40 per cent. of the heat value of the fuel burned is wasted through careless manipulation of the draft, so if the instruction "Be sure and burn one-third less coal, and less draft" can be consistently complied with and the heating and cooking satisfactorily accomplished, providers should recognize that its use may be accompanied by some benefit to household economy.

Lynn, Mass. CHARLES F. ADAMS.

❖

Economy of the Steam Loop

Much has been written about the steam loop and its method of returning the condensation directly to the boiler. To be sure, its simplicity is in its favor, but as in other power-station apparatus, economy cannot be overlooked.

The condensation will readily flow into the drips receiver by gravity and the flow from the elevated receiver into the boiler is due, of course, to the receiver pressure, plus the head, overcoming boiler pressure.

The energy required is in lifting the condensation from the lower receiver to the upper and caused by a difference in pressure again. This is provided by allowing more or less steam to be vented to the atmosphere. Now, the point is, how does this method compare in economy with that of a pump, maintained in good condition, and the maintenance noted, when the exhaust is utilized?

Union Hill, N. J. L. W. CULTER.

INQUIRIES OF GENERAL INTEREST

Paralleling Exciters—Will two exciters operate satisfactorily together when one is compound wound and the other shunt wound?

M. L. W.

No. If they must be operated in parallel it would be better to cut out the series winding of the compound-wound machine and operate both machines with shunt windings only.

Tube Beading—How much should 3½-in. tubes project beyond the heads of a return-tubular boiler at each end, to allow for beading when retubing a boiler of this type? Should the tubes be annealed before using?

B. H. S.

About ¼ in. Standard boiler tubes used in standard lengths do not require annealing for rolling or beading as they are already properly annealed, but if cut to shorter lengths than furnished by the manufacturer, the cut end should be annealed.

Boiler Feeding—Why is an injector for boiler feeding considered inefficient, when, except for the small amount of heat lost in the overflow, the heat of the steam consumed is returned to the boiler in the water?

J. B.

Injectors are more economical of steam than feed pumps, but for many purposes this advantage is offset by the objections that they become clogged, can draw only cold or moderately warm water, require dry steam for their operation and some skill to handle and that they generally are not adapted to graduation of feed nor continuous feeding.

Setting Thermostat—Having no thermometer or other instrument to measure the temperature how can a thermostat be set to operate at 376 deg. C.? There is a well in the steam line for a thermometer. Could not some substance be put in this well that would burn, melt or otherwise indicate when about the temperature required is reached?

L. B. T.

Lead melts at 620 deg. F. and zinc at 786 deg. F. Adjusting the thermostat to operate between these limits would probably be close enough to the desired temperature, 376 deg. C, or 709 deg. F., for all practical purposes.

Removing Tube Scale—How may the scale be removed from old boiler tubes which have been taken out to be lengthened by welding pieces on the ends?

B. H. S.

Boiler flues in quantities are cleaned in flue-cleaning machines by hanging a number of tubes in the loops of a pair of endless chains running over sprockets on horizontal shafts. Cleaning is accomplished by causing the tubes to roll over and over each other. Ordinary boiler scale can usually be cleaned with a strong solution of soda ash, after removing the thickest scale by lightly hammering the exterior surface of the tube.

Purging the Absorber—How often and where should the absorber of an absorption ice machine be purged? Is not the valve on the side for drawing a sample to test the strength of the liquor?

R. F. P.

At regular intervals, say once every two or three months, to blow off whatever air or other noncondensible gases have accumulated. Usually absorbers are blown off at the top as most of the gases contained are lighter than ammonia vapor. If there is any other valve except the purge valve, it can be used to draw off a sample of the liquor, but care should be taken that this valve is close to the strong liquor line where it leaves the absorber, otherwise the sample drawn may not represent an average of the strong liquor used in the refrigerating cycle.

Bolt Strain—Knowing the tensile strength of a bolt. how may it be calculated what force applied on the wrench handle in tightening the nut will break the bolt?

C. H. W.

Neglecting friction, the tensile strain will be equal to the force applied to the wrench, multiplied by 2 times 3.1416 times the distance (in.) of the force from the center of the bolt, divided by the pitch of the screw (in.) As in screwing up a nut the friction of both the screw thread and the bearing face of the nut must be overcome by the force applied to the wrench, the amount of tension brought on the bolt will depend on what per cent. of the power is lost in overcoming friction. In ordinary metal work the actual pressure of the nut or tension on the bolt would be 80 to 95 per cent. of the tension calculated without friction, depending on the character of the bearing surfaces.

Turbine Bucket Erosion—What is the relation of steam velocity to bucket erosion in steam turbines? It has been stated that the erosion is proportional to the square of the steam velocity, but that such a fixed law could hold hardly seems possible.

A. E. M.

The statement mentioned evidently is founded on the assumption that the work of erosion would be as the square of the steam velocity, but the rate of erosion would depend on the characteristics of the metal of the bucket as well as the velocity of steam, and it would be very difficult to state a fixed law. The rate of erosion is unquestionably influenced by the wetness of the steam and by solid particles of piping, nozzles, etc., that may be carried along with the steam, but the extent would depend on conditions for any particular case.

Simultaneous Pump Suction from Different Levels—A water supply is taken from two lakes about 1¼ miles from the plant, the farther lake 15 ft. higher than the nearer one and containing the larger amount of water. Water runs in from the far lake of its own accord, but this lake usually runs dry in August, compelling all of the water to be taken from the nearer lake and then pump trouble begins in loss of priming. Could a device be arranged to utilize the excess head of the farther lake to pull part of the water from the nearer lake, say three-quarters from the farther one and one-quarter from the nearer one, that would be automatic in its action? Such a device would save exhausting the farther lake.

C. G.

Probably a "jet pump" in the nature of a water ejector or eductor could be placed at the junction of the pipes leading from the lakes and the ejector could be so designed that the 75 per cent. supply of water drawn from the higher level could be employed for drawing in and carrying along the 25 per cent. of supply to be taken from the lower pond.

Air-Pump Power Consumption—What power would be consumed by a single-acting air pump making 60 r.p.m. geared down from a shaft running 1500 r.p.m. and working against a pressure of 120 lb., the pump having a 6-in. stroke and a 3-in. bore?

A. C. R.

The net power developed would be found by the formula

$$\text{Hp.} = \frac{P \times L \times A \times N}{33{,}000}$$

in which

P = Pressure, lb. per sq.in. (120);
L = Length of stroke, ft. ($\frac{6}{12}$);
A = Area of cylinder, in. (7.0686);

and

N = Acting strokes per minute (60).

Then,

$$\text{Hp.} = \frac{120 \times \frac{6}{12} \times 7.0686 \times 60}{33{,}000} = 0.77 \text{ net hp.}$$

The efficiency of the air pump would be about 60 per cent., so that the power required to be applied to the pump would be

$$\frac{0.77}{0.60} = 1.283 \text{ hp.}$$

The efficiency for the gearing would be about 90 per cent., so that the total power taken from the shaft would be

$$\frac{1.283}{0.90} = 1.42 \text{ hp.}$$

ENGINEERS' STUDY COURSE

Lubrication

Friction is the resistance of one surface sliding upon another; it is due to, and its extent depends greatly upon, the roughness of the surfaces. All surfaces, no matter how smooth and polished they may seem to the unaided eye, possess minute projections and hollows. Hence, when one surface is rubbed on another the projections of one catch into the hollows of the other and must be broken or worn off or lifted out before any sliding may take place. All this takes energy, and the amount of energy thus spent is called the loss due to friction.

Some surfaces naturally offer less resistance than others, and the condition of a surface also has its influence. Other things being equal the friction between two surfaces is almost directly proportional to the total pressure. The area of contact has but small influence except in extreme cases. The speed at which the surfaces rub over each other, provided this speed is not excessively low or high, has practically nothing to do with the amount of the friction developed. These things being true, the friction that a given bearing will develop can be estimated simply by figuring the weight to be carried and multiplying by a factor based on the slipperiness of the bearing surfaces. This factor is generally known as the coefficient of friction.

To reduce the effect of the naturally more or less rough nature of a bearing surface lubricants are employed. These are forced or work their way between the surfaces in contact, and tend to separate them, with the result that the minute projections and hollows cannot mesh thoroughly and, hence, the friction is reduced.

Lubricants are divided in three classes, solid, semi-solid and liquid. The action of the first two classes seems to be similar to that of a set of exceedingly minute rollers, which carry the weight or sustain the pressure while the bearing surfaces slide or roll on them. The action of the liquid lubricants is to form a film between the bearing surfaces upon which the pressure-imposing surface literally floats.

Solid and Semi-Solid Lubricants

The solid lubricants are graphite, plumbago, soapstone, etc. The first-named is the most widely used. To yield good results the bearings in which they are used should be of very hard material. Graphite is often mixed with oils and greases and usually a better lubricant results.

Semi-solid lubricants, or greases as they are commonly called, are made principally from mineral oils to which are added lime, soda or similar solid matter which will mix with the oil to form a smooth plastic substance.

Liquid Lubricants

Liquid lubricants or oils are divided into three groups, animal, vegetable and mineral. The animal oils commonly employed are lard, neatsfoot, tallow and whale or sperm oil. Those of vegetable origin are castor, corn and rape-seed oil. The oils of these two classes are known as fixed oils and solidify at ordinary temperatures. The animal oils solidify at higher temperatures than the vegetable variety. Animal and vegetable oils have the property of combining with oxygen from the air and for this reason are seldom used pure because the oxidation process causes them to become gummy and tend to increase friction. They are often mixed with mineral oils, however, as the latter are unaffected by oxygen.

The mineral oils are obtained from crude petroleum and form the class most extensively used for lubrication at the present time. Although petroleum is composed almost entirely of hydrogen and carbon, these two elements are combined in such a vast variety of proportions that by a process of refining the petroleum can be reduced to many products of widely different physical characteristics and uses. By applying heat in gradually increasing intensity and condensing the vapors given off, various products are obtained, beginning with the thinner or more volatile distillates, such as gasoline and benzine, then come the kerosenes and, finally, the various grades of lubricating oils. The latter are generally put through a process of purifying before they are sold for use. This consists chiefly of removing odor-forming constituents, any tarry substance that may have been formed during distillation, and improving the color.

After refining, the mineral oils may be compounded with animal or vegetable oils so as to yield a product possessing some of both the desirable and undesirable qualities of each. Animal and vegetable oils possess higher lubricating value—a higher degree of "slipperiness"—than the mineral variety. Hence, when compounded, they make for a more effective lubricant. But, as has been stated, they also possess the troublesome quality of gumming when exposed to the air, which the mineral oils do not. Hence, compounding serves to bring this factor within practicable limits.

Testing Oils

It is the opinion of many that the best test of a lubricant is that of service. In the case of greases this is about the only test within the reach of the engineer.

In the case of oil, several simple tests can be made before the real test of service is given. But here, too, the latter is the only truly reliable test that can be made. The other tests are often worth while, however, as they assist in comparing one lot of oil with another.

The usual tests made are viscosity test, specific-gravity test, cold test, flash test, fire test, gumming test, acidity test, and test for animal and vegetable oils and for "oil-pulp."

Viscosity

Viscosity is that quality of a liquid which tends to prevent its particles from separating; in other words, it is the quality which determines whether a liquid flows freely or sluggishly. Molasses is said to be very viscid because it "runs" slowly, while the viscosity of alcohol is low because it "runs" easily. The temperature of some

liquids, among which are the oils, has great influence upon their viscosity, the higher the temperature the more easily they flow. For this reason, the viscosity test, as usually conducted under ordinary temperatures, has little or no direct significance, especially in the case of the cylinder oils which are used at temperatures of 300 deg. or more.

The viscosity test is made with a viscosimeter of which there are numerous makes on the market. Most of them show the degree of viscosity by the time required for a given quantity of liquid to run through an orifice of given size. One make, however, employs a disk which is rotated in the liquid to be tested and the viscosity is estimated from the resistance the liquid offers. Viscosimeters range in price from $1.75 upward. For simply comparing oils or different shipments of the same oil a home-made apparatus will answer well enough. In its simplest form such an apparatus would be nothing more than a funnel, preferably of glass, with a small neck. In testing, the thing to remember is to keep conditions uniform throughout all tests made.

Fix the funnel in an upright position in a firm support, first making sure that it is clean and dry. Then measure accurately a given quantity of oil such that all of it can be put into the funnel at once. Stop the neck of the funnel with a finger or plug and pour in the measured oil. If more convenient, a mark can be placed on the funnel near its rim and the oil measured by filling the funnel to this mark. When the oil has been measured and filled in, remove the finger or plug and note the exact time by a watch or clock which shows seconds. If a stop watch is available better work will be possible. If the funnel used is of glass, a second mark can be placed close to or on the neck or narrow part and when the oil has run out to this level the time should again be noted as closely as possible. The elapsed time is an index to the relative viscosity. If the funnel is not transparent some other means of gaging the point of taking the second-time reading must be employed. A suitable point would be at the instant when the stream from the funnel broke into drops.

If the reader possesses the apparatus specified in the Nov. 4 lesson he may use the burette as a viscosimeter more conveniently perhaps than a funnel. In using it, however, care must be taken that the stop cock is always wide open, that the oil is filled in to the same level for each test and that the time is always taken when the oil runs out to a given level. As temperature has an important effect on the viscosity of oils care should be exercised in having the temperature of the oil and room always uniform in both summer and winter.

Specific Gravity

The specific gravity of a substance is the ratio of its weight to the weight of an equal volume of water. Thus, when we say the specific gravity of lead is 11.4, we mean that a cubic foot of lead weighs 11.4 times as much as a cubic foot of water at standard temperature. Hence, knowing the weight of water to be 62.355 lb. per cu.ft. at the standard temperature of 62 deg. F., it is an easy matter to multiply this figure by the specific gravity of lead to find the weight of the latter, thus

$$62.355 \times 11.4 = 710.8 \text{ } lb.$$

weight of 1 cu.ft. of lead.

The specific gravity of a solid body is found by dividing the weight of the body in the air by the difference between its weight in air and its weight when submerged in water. But the specific gravity of a liquid is usually found by means of a hydrometer or glass tube with a bulb at its lower end partly filled with mercury and with a scale on its upper end or stem. The hydrometer is placed in the liquid to be measured and being heaviest at its lower end floats in an upright position. The depth to which the instrument sinks depends upon the density of the liquid or its specific gravity. For oils, the Baumé hydrometer is the instrument usually employed. This instrument gets its name from its inventor and the scale on its stem, divided into degrees, is known as the Baumé scale. Hence, the specific gravity of oils is usually stated in degrees Baumé.

To convert degrees Baumé to specific gravity, where the liquid is heavier than water, divide 145 by the difference between 145 and the gravity of the liquid in degrees Baumé, as shown by the hydrometer. Where the liquid is lighter than water, divide 140 by the sum of 130 and the gravity of the liquid in degrees Baumé, as shown by the hydrometer. For accuracy, the liquid being tested must be at 60 deg. temperature. If it is not convenient to have the oil at 60 deg., for every 10 deg. above 60, subtract 1 deg. Bé. from the reading.

Cold Test

The cold test is not necessary unless the oil is to be used where the temperature is low. To make this test pack a 4-oz. bottle containing 1 oz. of oil and a thermometer of suitable range and size in a freezing mixture. When the oil hardens, remove the bottle and as the oil begins to warm up and soften, stir constantly to keep the temperature uniform throughout the mass. When the oil will run from one end of the bottle to the other read the temperature of the thermometer.

Flash and Fire Tests

This test (flash) also has its chief value as a means of identification, but in some cases it is valuable as a precaution against using an oil where the temperature encountered might cause danger of a fire.

The simplest form of test is to heat a quantity of oil in an open porcelain dish until flashes of flame across the surface of the oil are caused when a lighted stick is brought close to, but not touching it. A thermometer of suitable range is necessary and this should be immersed in the oil so that the bulb does not touch bottom.

The fire test is conducted in the same way as the flash test, except that the heating is continued until the oil gives off vapors fast enough to burn continuously, when a flame is applied. The temperature at that point is the fire-test temperature.

The balance of the tests, being complicated and difficult, are seldom attempted except in a properly equipped laboratory by a trained expert. However, inability to make these tests should not prevent a wide-awake engineer from securing a suitable and reliable grade of oil for his plant. An oil that is not suitable or one of inferior grade that is sold at a high price is bound to show up poorly in service.

Selecting a Lubricant

The selection of the best lubricant for a certain application is no simple problem. The man who is to secure

the best results must devote much attention to controlling conditions and learn largely by actual experience.

Generally speaking, the important factors are the speed and pressure of the bearing surfaces and, sometimes, temperature. Due precaution must be taken that the nature of the bearing surfaces is suitable; that the surfaces are in good condition and that the manner of supplying the lubricant is right.

According to W. H. Bailey, quoted in "Kent's Mechanical Engineers' Pocket-Book," the general requirements of a good lubricant are: Sufficient body to keep the rubbing surfaces free from contact under maximum pressure; greatest possible fluidity consistent with the foregoing condition; lowest possible coefficient of friction; greatest capacity for storing and carrying away heat; high temperature of decomposition; power to resist oxidation or the action of the atmosphere, and freedom from corrosive action on the metals of bearings.

For bearings under heavy pressure and operating at low speed the best lubricants are heavy greases and oils or solid lubricants. With higher speeds and lighter pressures, thinner or lighter oils or greases are suitable.

Prof. A. H. Gill gives the following hints in selecting a lubricating oil for bearings: Use the most fluid oil that will stay in place and do the work. The flash point should not be less than 300 deg. F. The best oil is that which possesses the greatest adhesion to metal surfaces and the least cohesion among its own particles. For light pressures and high speeds use mineral oils having a specific gravity of about 30.5 deg. Bé. and a flash point of not less than 360 deg. F. For ordinary service use mineral oils of from 25 to 29 deg. Bé. and having a flash point of between 400 and 450 deg. F.

Cylinder oils are usually compounds of heavy mineral stock and from 1 to 10 per cent., sometimes more, of fixed oil or fat, such as tallow oil, tallow, lard or lard oil. The reason for thus compounding is because pure mineral oil cannot adhere to wet surfaces and most steam cylinders are wet. The fixed oils and fats, however, readily mix or emulsify with water and this mixture does adhere to wet surfaces. Thus, by compounding mineral and animal oils, effective lubrication is secured. Care must be exercised, however, that only the necessary percentage of fixed oil or fat is used, because this very quality of mixing with water may cause trouble in the boiler, if the exhaust is returned with the boiler feed.

The fixed oil or fat compounded with the mineral oil should be of the highest quality obtainable; otherwise the metal of the cylinder walls is in danger from the acids. A simple way in which to detect inferior material is by the disagreeable smell which is given off when the oil is heated.

Tests by numerous engineers and investigators have shown that the addition of a suitable proportion of a proper grade of graphite to both cylinder and engine oils improves the lubrication and tends to reduce the quantity of oil required. Its use is to be undertaken with caution, however, as unless properly handled and applied new difficulties may be encountered.

⁂

Illinois Establishes New Coal-Producing Record—Figures made public by the statistician of the United States Geological Survey show that the production of coal in Illinois in 1912 was 59,885,226 short tons, valued at the mines at $70,294,338. This constitutes a record for the state. Coal is mined in half of the 102 counties, the total coal-formation area of the state is 35,600 square miles.

OVER THE SPILLWAY

JUST JESTS, JABS, JOSHES AND JUMBLES

Somebody recently said that the world is awakening to the fact that the Golden Rule is just plain common sense. Sure! But it takes a real fellow to carry out its specifications. There are many, and always will be, who wouldn't know it from the Kreutzer Sonata if it were set to music.

⁂

After 48 hours' imprisonment in a power-station boiler, a Utica-Italiano inquired on his release: "Is election day over?" And he wasn't in hiding either, gentle reader, as a repeater. Dominick Gaetano clum in to clean out the boiler, and someone clamped on the manhole cover. This man's a patriot! Most of us wouldn't care a cuss whether Fusion or Tammany got in; we'd be too keen on how to get out.

⁂

Slantha! Tim Healy, who's a coroner in New York City. In this column of Sept. 2 we said that "the only thing Tim ever runs from is his friends; offices, and enemies, he runs for, and gets them. As a coroner, he looks like a dead winner!"

But Tim ran away—away ahead of his ticket. Shure, Timmy darlint, if we were to die this day, 'twould be Hivin to have ye come an' sit on us!

⁂

"A pound of laughter is worth a ton of pills," says a contemporary. We usually meld the "150" and "40 jacks" in the smile game ourselves. How high we'd bid on a ton of pills, even at 2c. a hundred— Say, is this a long ton, f.o.b., or what?

⁂

Brother Van Keuren, Famoso, Calif., sent this clipping:

"TULARE, Oct. 10.—A. Marquehose was severely burned at noon by an explosion of gas and oil in the firebox of the steel digger, at work on the trenches for water mains in this city. Marquehose was working with the oil feed to the firebox on the steam engine when accumulated gas ignited the oil. The flame shot out directly in his face. He was burned about the neck, ears and face. His hair was all singed off in front."

⁂

A West Virginia schoolma'am has installed a small isolated plant in an anteroom of the schoolhouse. It's necessarily a heating plant because it's an electric "spanker." This engine delivers 5 s.b.p.s (5 sharps blows per second). The lady engineer says that while the run is short, it's long on efficiency. Central stations might adopt the "spanker" as a means of building up a day load.

⁂

"With artificial ice, care must be taken not to let fish come in contact with it, as the ammonia used in freezing it affects the fish."—N. Y. "Times."

Help! Don't you know, dear "Times," that a couple of sticks of ammonia laid crosswise of a fish's neck just hypnotizes it so that nothing ever after will affect it?

⁂

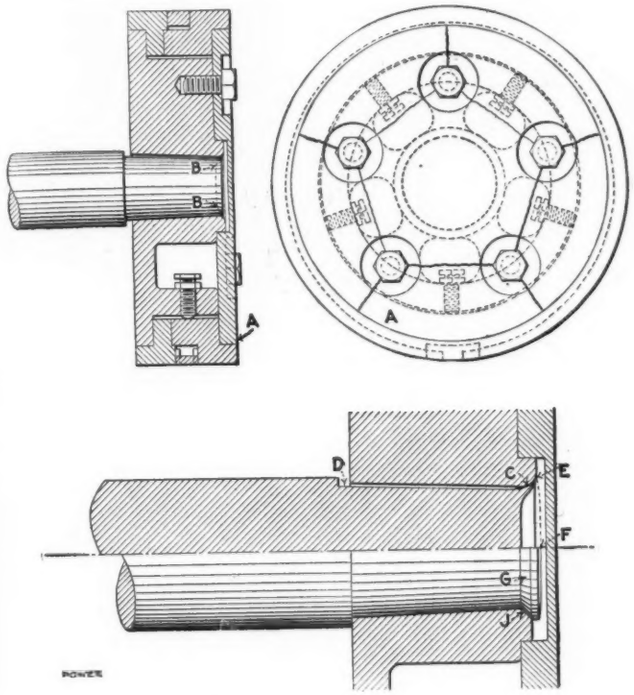
We used to think that as boosters the Western fellows took the brass ring, but that merry crowd of Beaners in the Commercial Engineers get away with the whole dinged carrousel. Now, they're boosting the coming Boston Power Show in their bright little "Bulletin." Reads like these boys just went around in bunches with their arms about each others' necks—and we bet they do, too. Get the formula, you "other" people, and be a real feller!

⁂

The Swedish scientist, Alfred Nobel, and the inventor of dynamite, left $9,000,000 as a fund, the interest to be distributed to those who had contributed most to "the good of humanity." The value of each prize foots up to about $40,000, the prizes being awarded every year. The medicine prize goes to Charles Richet, of the French Academy of Medicine, for his work in anaphylaxis. He has invented an air filter to purify the air in rooms, and act as a preventive of the spread of scarlet fever, tuberculosis and other diseases. It is a ventilator worked by electricity, which displaces 200 cu.m. of air an hour. The apparatus in which the fans revolve is covered on the inside with glycerine, on which all the germs, spores and such matter in the air are deposited and eliminated from the air of the room.

Failure of Piston-Rod Riveting

It is quite probable that failure of poor riveting of the ends of piston rods over engine pistons has been the prime cause of many mysterious engine wrecks. A case of failure of piston-rod riveting was recently brought to our attention which on analysis is easily understood to have resulted from carelessness or ignorance in design and workmanship. The quick perception of the engineer that something unusual had taken place in the right-hand cylinder of a double Corliss engine, his presence within reach of the throttle and quick action in shutting down



FAILURE AND REPAIR OF PISTON-ROD RIVETING

undoubtedly averted a smash which would probably have gone down into the history of the plant as mysterious or been attributed to negligence of the operating engineer.

The failure of piston-rod riveting occurred in the left-hand cylinder of the double 16x36-in. noncondensing Corliss engine at the Ward St. (Paterson, N. J.) mills of the Silk City Real Estate Co. The engine had been running 80 r.p.m., supplied with steam at 80 lb. boiler pressure and with usual day load cut off at about one-third stroke, the side of the engine which was crippled having carried the same load 55 hr. per week from the dates of its installation, which was about a year and a half prior to the piston-rod failure.

Ten minutes after starting for the afternoon run the engineer noticed that a slamming noise had set up against the head of the left-hand cylinder, which ceased as he closed the throttle and then as the engine was brought to rest there was heavy pounding at the end of every out stroke of the piston. Upon removing the cylinder head it was discovered that the heads of the piston follower cap-screws had been striking the cylinder head and that the piston follower *A* was broken in six pieces, as shown in the end view of the piston.

Upon removal of the follower plate it was seen that the flange riveted over the end of the piston rod had been drawn into a cupped form, as indicated by the dotted line *BB*, and upon removing the piston and rod from the cylinder it was discovered that the only remaining hold of the piston rod on the piston was by contact of the drawn-over flange and rounded countersinking of the piston, as shown at *C*.

From the amount of withdrawal of the rod out of the piston, as shown by the distance the shoulder *D* had left the piston, and the form of cupped end of piston rod, it was found that the riveting over must have been in the form *CEF*, leaving a triangular flange of little more than $\frac{1}{8}$x$\frac{1}{8}$ in. to resist stresses of shearing and drawing which for a 16-in. diameter piston and 80-lb. square-inch pressure of steam, without allowance for friction of the piston rod in the tapering bore of the piston, would amount to about 16,000 lb. The engineer is positive that the break and failure of the riveting was not caused by the presence of water in the cylinder as the water level of the boilers was low, water had never been known to be carried over, and there was no pounding or other indication of water in the other cylinder of the engine.

Repairs were made by extending the taper about $\frac{3}{16}$ in. further back on the rod and turning about the same amount off the hub of the piston at *E* and countersinking the hub about $\frac{3}{16}$x$\frac{3}{16}$ in., as shown at *J*. After trimming off the end of the rod the piston was forced on the rod up to the new shoulder, requiring a pressure of 25½ tons and then a head of the form shown at *G* was riveted on, affording about twice the previous shearing strength, and being double the thickness, should afford at least four times the resistance which the original riveting offered against being drawn over. After supplying a new follower plate and replacing the piston and rod the engine worked satisfactorily.

Ogden (Utah) Power Plant Wrecked

On Oct. 26 an opened valve on the penstock supplying water under 450-ft. head to turbines being installed in the 12,000-hp. station of the Utah Light & Ry. Co., Ogden, Utah, wrecked the plant, depriving that town of lighting and stopping the street-railway service for a short time. The loaded machinery was burned out, the plant flooded and part of the brick curtain walls carried away.

The 42-in. valve on the main intake pipe had a broken bronze ring which blocked the valve and only closed it one-half. The motor operating the valve was cut off. The steel work and the foundations of the station are not damaged. The extent of the loss has not as yet been determined.

Conservation Congress at Washington

The fifth National Conservation Congress will be held at Washington, D. C., Nov. 18, 19 and 20. It is intimated that in the next few months the fight for the protection of the country's forests and waterways will command the attention of the nation and that the question of state rights is to play an important part in the coming combat. The officials of the Conservation Congress are concerned over activities in the West in the interest of state ownership and control of the national forests and waterways. So great is the clamor in some circles that it is understood that the conservation interests realize the importance of definite steps to prevent the states from wresting the control of these resources from the Federal Government.

Gasoline Freight Engine—The Minneapolis Northern R.R. has a new gasoline freight and switching engine. It has a capacity of pulling 20 cars. Also a 200-hp. six-cylinder, air-starting and reversible gasoline engine, modified to adapt it to heavy freight service. The engine is water-cooled by two radiators, located on the cab roof, and a gear pump. One operator handles the engine and does it with ease.—"The Gas Engine."

Manhattan and Bronx, N. A. S. E., Annual Reception

At Terrace Garden, New York City, on the evening of Nov. 1, the twelfth annual entertainment and reception of the Combined Associations of Manhattan and the Bronx, N. A. S. E., was held. The attendance was very large and the whole affair most successful.

MEMBERS AND GUESTS AT THE COMBINED ASSOCIATIONS RECEPTION

Among the visiting national officers were President James R. Coe, Secretary Fred W. Raven, Treasurer Samuel B. Forse. Conductor John L. Reddy, Past Presidents Joseph F. Carney and William J. Reynolds, Trustees William W. McLean and George W. Brownhill and James D. Taylor, secretary of the life and accident department. The general committee were Lorenzo S. Everson, James D. Taylor, William M. Logan and Frederick Feldermon.

An entertaining vaudeville was given by Morgan and Morgan, comedy acrobats; Murray, Russell and Dunn, rapid-fire entertainers; Allen and Dalton, musical comedians; Braddock and Braddock, in a comedy sketch; George Andrews, comedian; Francesca Redding and Co., in a popular vaudeville offering; Clark and Watson, eccentric jugglers.

The combined associations of Manhattan and the Bronx are Brotherhood No. 1, Protective No. 23, Manhattan No. 25, Empire No. 32, Mott Haven No. 47, James Watt No. 7, Phoenix No. 24, German-American No. 29, Stevenson No. 44, Insurance No. 56.

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Opposition to Buffalo Power Company

On Oct. 26 the Buffalo aldermen authorized Corporation Counsel Hammond to oppose the application of the Canadian-American Power Corporation to issue $2,999,500 of its stock to pay for a contract for the delivery of power at $12.50 a horsepower. The matter is now before the public-service commission.

Mr. Hammond says that the company proposes to build a transmission line from Niagara Falls to Buffalo city line. It appears that the proposed corporation does not now intend to distribute electrical energy in Buffalo, but, notwithstanding its plans should be carefully scrutinized, Mr. Hammond says that there is no justification for the capitalization of the contract at nearly $3,000,000, as the public-service commission in the case of the Cataract, Power & Conduit Co. refused to capitalize a contract of the latter corporation.

"The applicant company," says Mr. Hammond, "proposes to issue $2,999,500 of its common stock in payment for the contract which requires the Electrical Development Co., of Ontario, and the Toronto Power Co. to deliver at the international boundary 46,000 hp. of electrical energy for 30 years at $12.50 a horsepower. In other words, the company asks the public-service commission to approve of the issue of nearly $3,000,000 worth of stock to pay for a contract for the delivery of power at $12.50 a horsepower—a price which is higher than that now being charged for similar power in the same locality.

"If the commission should approve of this stock issue, it is apparent that when a question of rates to be charged for power comes before the commission for determination it will be difficult for the commission to refuse to consider that contract as having a value equivalent to the par value of the stock issued for it.

"The city would be in a much worse situation if it attempted to compel a reduction of rates as it was in the case of the Cataract Power & Conduit Co. In that case, a contract of a similar nature had been capitalized for a large sum of money, and although it was less than the amount of capitalization now sought, the capitalization had never been approved by the public-service commission, and the commission was in a position, as it did, without embarrassment to itself to disregard the capitalization.

"While I think no one would dispute the assertion that the bringing of additional power to Buffalo would be desirable, I think it is equally plain that the public interest requires that a company which may ultimately bring power to the city should not be allowed to issue the amount of securities largely in excess of the value of its tangible properties."

SOCIETY NOTES

The fall meeting of the New Haven Section of the American Society of Mechanical Engineers will be held on Friday, Nov. 21, at the Mason Laboratory, Sheffield Scientific School. The interesting program of papers includes "Experiments with Residence Heating Boilers at the Mason Laboratory," by D. B. Prentice, of Sheffield Scientific School. The school's electrical laboratory has been completed and an opportunity will be given during the intermission to inspect the building and its equipment.

The New York Engineers' Protective Society, the oldest engineers' association in New York City, held its 45th annual entertainment and reception on Monday evening, Nov. 3, at the Lexington Opera Assembly Rooms, which were tastefully decorated for the event. A pleasing vaudeville entertainment preceded a long dancing program. The committee of arrangements were: Andrew Olsen, chairman; William Boeringer, secretary; Charles Knudsen, treasurer.

The Ladies' Auxiliary, connected with the N. A. S. E., of Brooklyn, N. Y., held its annual euchre and beefsteak supper on Nov. 4 at the rooms of the Modern Science Club. At 3 p.m. the games were started, for which prizes were awarded. In the evening a generous supply of eatables was furnished and between the courses the election returns were read by P. O. P. Smith. There was a good entertainment, which concluded with dancing.

PERSONALS

Timothy Healy, international president of the Eccentric Firemen, was elected a coroner for Greater New York on the Fusion ticket. Mr. Healy ran ahead by some thousands of votes over four other elected coroners.

John Beattie, formerly at the Long Island plant of the Pennsylvania R.R., has been appointed chief engineer of the Gould St. power station of the Consolidated Gas, Electric Light & Power Co., Baltimore, Md.

BOOKS RECEIVED

HYDRAULIC TURBINES. By R. L. Daugherty. McGraw-Hill Book Co., New York. Cloth; 156 pages, 6x9¼ in.; 96 illustrations. Price, $2.

ELECTRIC AND MAGNETIC CALCULATIONS. By A. A. Atkinson. D. Van Nostrand Co., New York. Fourth edition; cloth; 310 pages, 4¾x7¼ in.; 45 illustrations; tables. Price, $1.50.

WORKING DRAWINGS OF MACHINERY. By W. H. James and M. C. Mackenzie. John Wiley & Sons, Inc., New York. Cloth; 143 pages, 5¾x9 in.; 175 illustrations; plates; appendix illustrated and tabulated. Price, $2.

HEAT ENGINES. By William Ripper. Longmans, Green & Co., New York. Cloth; 352 pages, 4¾x7½ in.; 214 illustrations; appendix. Price, $1.10.

WORKING OF STEAM BOILERS. By Edw. G. Hiller. Taylor, Garnett, Evans & Co., Manchester, England. Fifth edition; paper and cloth binding; 147 pages, 5¼x8½ in.; 85 illustrations. Price, 1/6. Bound full cloth, 2/-.

HEAT. By J. A. Randall. John Wiley & Sons, New York. Cloth; 331 pages, 5x7½ in.; 80 illustrations; tables. Price, $1.50.

PRINCIPLES OF INDUSTRIAL ORGANIZATION. By Dexter S. Kimball. McGraw-Hill Book Co., New York. Cloth; 272 pages, 6x9½ in.; illustrated; tables. Price, $2.50.

TURBINES APPLIED TO MARINE PROPULSION. By Stanley J. Reed. D. Van Nostrand Co., New York. Cloth; 174 pages, 7½x11 in.; 113 illustrations; plates. Price, $5.

NEW PUBLICATIONS

FOREIGN WEIGHTS, MEASURES AND MONEYS. By John J. Macfarlane. Published by the Foreign Trade Bureau of the Philadelphia Commercial Museum. Philadelphia, Penn. Paper, 6x9 in.; 62 pages, tables.

One of the first difficulties which confronts the United States merchant or manufacturer entering into trade with foreign countries is the diversity of the weights and measures used by them. The present pamphlet was written for the information of the manufacturer as an aid in establishing closer commercial relations with foreign countries. It describes the metric system and contains a very complete set of comparative tables, including a list of the various money denominations, weights and measures used in all foreign countries with the United States equivalents and also prices in foreign moneys per foreign weights or measures in comparison with our own prices per pound, yard, gallon or bushel. The comparisons in prices are made from foreign to United States and vice versa, and in the final chapter the usual foreign currency signs and abbreviations are given. To those with foreign interests the pamphlet should prove of the greatest value.

STEAM BOILERS. By E. M. Shealy, Assistant Professor of Steam Engineering, University of Wisconsin. Published by McGraw-Hill Book Co., New York. Cloth; 356 pages; 6x9 in.; 185 illustrations. Price, $2.50.

This work was written primarily for correspondence students, and is intended for the use of firemen and others who may be in charge of boiler rooms. The title, "Steam Boilers and Their Practical Operation," would have been better suggestive of the subject matter, as the operation of boilers rather than their design is treated in considerable detail. Descriptive matter relating to boilers and boiler-room equipment is included for information of firemen and others who may be familiar with only the particular equipment which they may be using. A single chapter of 19 pages is devoted to types of flue and fire-tube boilers, and another of the same length illustrates and describes ten of the more important forms of water-tube boilers, the descriptive matter being only general without referring very extensively to details of mechanical construction. The chapter on water-tube boilers closes with a section which briefly though concisely states the advantages and disadvantages of the flue, the fire-tube and the water-tube types of boilers. Chapter III on boiler calculation treats of horsepower referred to measurements of boilers; methods of measuring corrugated flues; strength of shells and of furnace flues; method of measuring heating surfaces; and general description of rivets and riveting, stays and staying.

The chapters on heat and work and on properties of steam comprise definitions of terms expressed in good language and clearly illustrated for easy comprehension of the practical mind. A chapter devoted to "Actual and Equivalent Evaporation" describes methods of determining the percentage of moisture in steam, separating and throttling calorimeters, their construction and use. The subjects of fuels, chemistry of combustion and flue-gas analysis have received good practical treatment, and the chapter on firing and the operation of leading types of stokers and chain grates and that on smokeless combustion of coal present those subjects in a manner to be appreciated by firemen, engineers, proprietors or others interested in the problem of smoke prevention.

A chapter on boiler settings contains simple explanations of Dutch ovens and details of return-tubular and water-tube boiler settings, known only by hearsay to many firemen and operating engineers whose experience has been limited to their own plants. The leading essentials of piping and boiler fittings, including a table of dimensions, weight and pitch of screw threads of pipe and fittings are given in a separate chapter, while another is devoted to clear description and explanation of boiler accessories such as dry pipes, leading types of superheaters, damper regulators, feed pumps, injectors, etc. Chapter XVI is devoted to chimneys, draft and economizers and three succeeding chapters are devoted to boiler-feed waters, feed-water heaters and the inspection and care of boilers.

The last chapter describes how to conduct evaporative tests and by an example shows the method of calculating the results, with sample log sheets for data of coal, water, draft, quality of steam and flue gas. The work is printed on good paper with text printed in large, readable type with subjects in side headings printed in heavy-faced type. The general illustrations consist of well prepared halftones and the details illustrated are reproduced to a good, readable scale.

MECHANICAL AND REFRIGERATING ENGINEERS' HANDY-BOOK. By Otto Luhr. Published by Wahl-Henius Institute, Chicago, 1913. Cloth, 6¼x9¼ in.; 900 pages; 312 illustrations; 109 tables; indexed. Price, $5.

In its 900 pages the book contains a wealth of information on practically every subject in which a refrigerating or mechanical engineer would be professionally interested. Naturally some of the subjects are treated briefly, but the material is right to the point and thoroughly uptodate. The book is admirably adapted for the practical man, and although it contains numerous formulas, these are made as simple as possible, and their application is thoroughly explained by the use of practical examples, worked out step by step, which follow in each case. The part of the book dealing with refrigeration contains over 200 pages, and as a whole is the best treatment on this subject that we have seen in print. The fact that some of the most recent apparatus brought out in this field are described in its pages, and that it contains one of the latest tables giving the properties of ammonia will indicate that it is right up to the minute. The refrigerating engineer in practice must in most cases know something about steam and electrical machinery, the transmission of power, gas engines, air compressors, and perhaps heating and ventilation. He will find it all in this book and presented in a form that he will understand.

The first chapters of the book devote 69 pages to physics, 26 pages to electricity and magnetism, 41 pages to chemistry and 38 pages to combustion. Steam boilers and accessories and calculations relating to them are given 74 pages and 59 more take up the properties of steam, steam appliances and the treatment of boiler water. Steam engines are covered in 49 pages. Sixteen pages are given to the steam-engine indicator, 14 to the steam turbine, 18 to the internal-combustion engine, 36 to the transmission of power, 22 to pumps and 9 to air compressors.

As previously mentioned the section on refrigeration is particularly good and somewhat more elaborate. Physical laws bearing on refrigeration, refrigerating systems, machines and apparatus belonging to the compression and absorption systems, the brine system, insulation, liquid-air machines and applications of refrigeration are all covered in a satisfactory manner.

Following is a chapter of 42 pages on electrical engineering, discussing briefly the principles, testing and operation of generators and motors and giving some space to converters, transformers, incandescent and arc lighting, storage batteries, and electrical calculations. Sixteen pages are allotted to heating and ventilation. Only a few paragraphs relate to hot-water heating and these to the gravity system. Short chapters on pipes and pipe fittings, friction and lubricants, mensuration, weights and measures and mathematical tables complete the book.

As will be seen some of the chapters are brief and for a more extended treatment it will be necessary to refer to some other book dealing only with the subject in hand. As a practical reference, however, giving methods of calculation and a concise summary, the book is good and can be heartily recommended to the practical man, especially the refrigerating engineer.

TURBINES APPLIED TO MARINE PROPULSION. Sy Stanley J. Reed. Published by D. Van Nostrand Co., New York, 1913. Cloth, 7¾x10¾ in.; 174 pages, 113 illustrations. Price, $5, net.

A thoroughly good book admirably covering the subject should be the general verdict of readers. The contents consist largely of a special course of lectures given by the author at the Naval Architecture Department of Glasgow University. The book is noteworthy for its fine illustrations, both halftone and line. Contrary to a practice often prevalent in books, the value of the illustrations is not diminished by overreduction. Many of the halftones are full page, and the line drawings of the turbines are on three- and four-fold inserts. Thermodynamics and mathematics are, of course, necessary in a work of this character, but are entered into sparingly as the book is primarily intended for practical use. The first eight chapters, occupying 100 pages of the book, take up the general properties of steam, turbine types, the general design and construction of the leading turbines, their steam consumption, thrust and how balanced, and nozzles. Superheated steam and types of superheater are then discussed briefly and the following chapter takes up cavitation, propeller speed and mechanical, hydraulic and electrical reduction gearing. Other subjects treated are effects of high vacua, condensers and air pumps and the utilization of engine exhaust in turbines and feed heaters. Detail of design has been eliminated except in the last chapter, which takes up a few special points on cylinders, rotors, bearings, thrust blocks, diaphragms, glands, steam pipes and turbine drains. Balancing rotors, measuring steam consumption, jointing cylinders, etc., are also given brief space in the chapter.

Able assistance by such authorities as Herr Zoelly, Professor Rateau and the A. E. G. Co. to an author thoroughly posted on his subject and knowing how to diffuse his knowledge has resulted in a well balanced book, which should prove a valuable addition to the literature on the subject.

Coal in Ancient Lake Beds

The presence of coal in the Tertiary Lake beds of certain valleys in western Montana has been known locally for many years. Some localities have even experienced brief coal "booms," most of which, however, died before the coal was developed. Systematic mining of the coal is now being carried on near Missoula.

Coal of the type found in this region has until recently been thought worthless, because only coal that would coke or stand shipment without slacking was considered of commercial value. In this part of the West, where high-grade coal is scarce, where the cost of wood has reached $6 or more a cord, and soft coal, imported for domestic use, about $8 a ton, the demand for cheaper fuel is great and the development of these heretofore unused low-grade coals is becoming profitable.

That these low-grade coals may furnish gas of good quality at a moderate cost and briquettes suitable for domestic fuel is suggested by the results of experiments with coal of a similar type recently carried on at the University of North Dakota by E. J. Babcock. On this account an investigation of the coal resources of parts of Missoula, Ravalli, Granite, Powell, Deer Lodge and Silver Bow counties, in western Montana, has been made by the United States Geological Survey in order to obtain data for the classification of the public land in the area and to supply the public with information about the coal.

The field work in this area was carried on by J. T. Pardee, of the Survey, and the results of his investigations have just been published as Advance Chapter G from Bulletin 531, entitled, "Coal in the Tertiary Lake Beds of Southwestern Montana."

Though a local demand for cheap domestic fuel will cause some further development of these Montana coals, anything like a rapid future development of them will depend on an increased use of producer gas for the generation of power, for which these coals seem well suited, or the introduction of briquetting machinery which will convert the easily slacked coal into briquettes that may be shipped and stored without deterioration.

Oil and Gas in Utah

A brief report on the oil and gas development near Green River, in Grand County, Utah, has just been issued by the United States Geological Survey as a result of a geologic investigation made last year by Charles T. Lupton, M. W. Ball and R. V. A. Mills, of the survey.

An area of about 300 square miles was examined, the object being to determine if this area, in which considerable drilling for oil and gas has been done, contains any reservoirs of these materials. In the area examined in detail the geologists found no anticlines or domes in which large quantities of oil or gas might be expected to collect. Traces of oil and small pockets of gas have been encountered in some of the wells, but in quantities so small as to afford only slight encouragement.

While the survey's report presents no very favorable impression of the field as an oil or gas producer, such deposits are recognized as among the most difficult to locate or determine exactly, and for this reason several suggestions are offered as to the portions of the field which hold out the greatest promise for prospecting. A copy of this report, which is advance chapter D of Bulletin 541, may be obtained free of cost upon application to the Director of the United States Geological Survey, Washington, D. C.

Operating Engineers, industrial concerns, and persons interested in the distribution and character of the different coals will find valuable information in Bulletin 22, just issued by the Bureau of Mines, entitled, "Analyses of Coals in the United States, with Descriptions of Mine and Field Samples Collected between July 1, 1904, and June 30, 1910." It contains the analyses of 5000 samples taken from 1500 mines and prospects situated in the various coalfields of the United States. The purpose of the compilation is to present reliable information regarding the chemical composition and the heat value. The samples were collected by experienced men and were analyzed under carefully controlled conditions. The report is in two parts, one giving the methods used in collecting and analyzing the samples, and the results of the analyses, and the other, the exact location from which each sample was taken, together with a description of the characteristic features of the coal bed at the point of sampling, the nominal capacity of the mine, and useful notes on coal preparation. The data is not equaled in scope, detail and value for comparative purposes by the figures of any other coal-producing country in the world. Some governments have published analyses of coals from different mines and from different districts, but, with few exceptions, the samples were not collected and analyzed under a uniform system that would make the results comparable in all respects. Copies of this bulletin may be obtained by addressing the Director of the Bureau of Mines, Washington, D. C.

The Largest Conveyor Belts in the world, it is claimed, are being built by the Perdriau Rubber Co., Ltd., of Sydney, N. S. W., for a coal-loading plant at Fort Kembla. The belts are being made after specifications of the Public Works Department; each is approximately 1650 ft. long and will weigh 12 tons, being made up of seven-ply rubber and cotton in one continuous length, without joints, 36 in. wide. When rolled each belt will be too large to pass through the railway tunnels on the way to the port. The conveyor will carry coal about 1600 ft. at a rate of 1000 tons an hour.

One of the features of the most particular interest connected with the Lemp Brewing Co.'s plant, described in our issue of Sept. 23, was the boiler-feed pump equipment. By an oversight it was neglected in that article to say that the modern equipment was supplied by the Alberger Pump & Condenser Co.